

PROGRESS REPORT FOR THE BIOENVIRONMENTAL RESEARCH
MAY 22, 1964 THROUGH JULY 1, 1966
PART I
EXPERIMENTAL DAIRY HERD

by
Donald D. Smith and Ronald E. Engel

Bioenvironmental Research
Southwestern Radiological Health Laboratory

Department of Health, Education and Welfare
Public Health Service
Consumer Protection and Environmental Health Service

March 1969

Copy No. 53

DTIE
Oak Ridge, Tennessee

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

A. Makes any warranty or representation, expressed or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or

B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission, or employee of such contractor, to the extent that such employee or contractor of the Commission, or employee of such contractor prepares, disseminates, or provides access to, any information pursuant to his employment or contract with the Commission, or his employment with such contractor.

This study performed under a Memorandum of
Understanding (No. SF 54 373)
for the
U.S. ATOMIC ENERGY COMMISSION

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

124

TABLE OF CONTENTS

TABLE OF CONTENTS	i
LIST OF TABLES	iii
LIST OF FIGURES	iv
I. INTRODUCTION	1
II. USPHS EXPERIMENTAL FARM FACILITIES	5
A. DAIRY BARN, AREA 6, NTS	5
B. MILKING AND METABOLISM LABORATORY, AREA 15, NTS	6
III. ANIMAL HUSBANDRY	13
A. BACKGROUND	13
B. NUTRITION	13
C. IDENTIFICATION OF DAIRY COWS	16
D. RECORDS FOR DAIRY HERD	17
E. MILKING PROCEDURES	18
F. VETERINARY MEDICINE	20
1. Mastitis	20
2. Metabolic Disturbances	21
3. Digestive Disturbances	21
4. Calf Scours	22
5. Enterotoxemia	22
6. Veterinary Surgery	23
a. Teat Surgery	23
b. Hoof and Foot Surgery	23
c. Abdominal Surgery	23
d. Experimental Surgery	24
7. Routine Blood Examinations	24
G. DISCUSSION	24
IV. HERD PARTICIPATION IN USPHS EXPERIMENTS	39
A. INTRODUCTION	39
B. PROJECT TORY II-C	44
1. TORY II-C--INTERMEDIATE RUN, May 11-17, 1964	45
2. TORY II-C--FULL POWER, May 20-25, 1964	45

C. RADIATION BIOLOGY LABORATORY EXPERIMENT, RB-1, AUGUST 10-17, 1964	46
D. PROJECT KIWI REACTOR	46
E. PROJECT SULKY, December 18, 1964	47
F. PROJECT TNT, January 12, 1965	48
G. PROJECT PALANQUIN, April 14, 1965	50
H. PROJECT MILKRUN, August 11, 1965	52
I. PROJECT HAYSEED, October 4, 1965	54
J. PROJECT ALFALFA, June 21, 1966	56

APPENDIX

DISTRIBUTION

LIST OF TABLES

Table 1.	Selected Nutritional Components of NTS Hay.	14
Table 2.	List of Suppliers of Dairy Feed Supplements.	16
Table 3.	Average values of total protein, PB ^T , and TBI for entire herd except Cows 1, 2, 5, and 11.	32
Table 4.	Average of Complete Blood Counts for Entire Dairy Herd Except Cows 1, 2, 5, and 11.	35
Table 5.	Groups of Cows for PROJECT TORY II-C--Full Run, May 20, 1964.	46
Table 6.	Groups of Cows for Project KIWI.	47
Table 7.	Groups of Cows for Project SULKY, December 6-19, 1964.	48
Table 8.	Groups of Cows for TNT, January 13-18, 1965.	49
Table 9.	Groups of Cows for Project PALANQUIN, April 5- May 2, 1965.	51
Table 10.	Groups of Cows for Project MILKRUN, August 11-September 2, 1965.	53
Table 11.	Groups of Cows for Project HAYSEED, October 4-22, 1965.	55
Table 12.	Groups of Cows for Project ALFALFA, June 21-July 6, 1966.	57
Table I-A.	Grain Feeding Table for Cows Not on Pasture.	66

LIST OF FIGURES

Figure 1.	Area 15 Experimental Farm Building Complex, October 1965.	7
Figure 2.	Custom-built grain feeders which facilitate decontamination and feeding procedures.	8
Figure 3.	Typical milking scene with the Surge milking buckets and cows in place.	10
Figure 4.	Covered hay storage area and feed bunks which protect hay and animals from the direct sunlight.	11
Figure 5.	Sunshade for dairy cows kept in the loafing area.	12
Figure 6.	USPHS dairy cows in stanchioned feed bunks used for feeding green chop.	15
Figure 7.	Mastitis incidence USPHS Dairy Herd.	26
Figure 8.	Average Milk Production per Cow per Month.	27
Figure 9.	Percent of Herd in Production per Month.	28
Figure 10.	Herd Average Butterfat Percentage.	30
Figure 11.	Values of Total Protein, TBI, and PBI for Dairy Herd (except Cows 1, 2, 5, and 11) from April 1965 to June 1966.	34
Figure 12.	Front View of Feed Box Holder Attached to 9' x 9' x 5' Steel Pipe Portable Pen.	41
Figure 13.	Plastic Feed Box Being Inserted in a Feed Box Attached to a Portable Pen.	42
Figure 14.	View of the Back Side of the Feed Box Holder Attached to the Front of the Portable Pen and the Automatic Waterer.	43

I. INTRODUCTION

In the spring of 1963, a meeting chaired by Dr. Gordon Dunning was held at the Atomic Energy Commission, Nevada Operations Office (AEC/NV00) Headquarters, Las Vegas, Nevada. The purpose of this meeting was to examine the knowns and unknowns related to potential radioiodine doses which could result to humans from the release of mixed fission products into the biosphere, particularly as a sequel to nuclear weapons or excavation experiments. Separate subcommittees considered the following four areas with major questions to be answered as indicated.

1. Source: How does one determine how many curies of the radioiodines have escaped to the biosphere from a specific event?
2. Transport: How does one predict and then measure diffusion and deposition parameters as a function of distance and time when radioiodines from a given source interact with ambient meteorological conditions?
3. Environmental Monitoring: What environmental measurements are necessary to confirm or negate predictions made by the transport calculations and to serve as input for biological studies?
4. Biological Studies: From a given source of radioiodines acted upon by ambient meteorological conditions, what ultimate dose to man will result as a function of time, distance, and pertinent uptake parameters?

The total committee, comprised of a group of experts in each field, considered the many questions which have been only outlined above. A rather lengthy detailed report resulted which clearly indicated that, for actual field sources of radioiodines, many essential bits of

required information were lacking in all areas. Thus, specific recommendations were made for the development of field and laboratory research projects to obtain the missing data.

In brief, the committee concluded that source term definition was primarily the province of the laboratory constructing the nuclear device being tested and that a coordinated major research effort was needed in the combined areas of transport, environmental monitoring, and biological studies. Subsequently, the AEC awarded the U. S. Public Health Service a long-range safety program contract to mount the necessary studies with Environmental Sciences Service Agency (ESSA) support to assist in the transport phases of the studies.

The Bioenvironmental Research Program came into being on July 1, 1963, with the mission of developing the necessary capabilities in staff skills, facilities, and equipment to design and conduct required research studies to obtain answers to the questions posed by the AEC. It was clear at the outset that a fully coordinated effort of ESSA personnel and representatives from many diverse scientific disciplines would be required to attack the many problems to be solved.

The major approach conceived can perhaps best be described as problem-oriented systems research. As mentioned previously, the source term definition is considered to be the province of the scientific laboratory which manufactures the device being tested. Transport phenomena studies are the primary responsibility of ESSA. The remainder of the studies are then the specific responsibility of the Bioenvironmental Research Program which is an integral part of the Southwestern Radiological Health Laboratory (SWRHL), Las Vegas, Nevada.

The systems approach which is used consists of measuring pertinent input parameters to each system and then measuring the output of interest. With this approach it is not necessary to fully elucidate all the inner workings and detailed hidden mechanisms which function within any system.

Of course, as knowledge of the input-output relationships of the major systems grows, it is planned to intensify research in the smaller subsystems in order to gain some knowledge of the mechanisms at work.

In general, there are two separate types of situations for which we design and conduct field experiments. These are described below.

1. All nuclear tests in which there is a reasonable probability that some radioactivity will be released to the atmosphere. An example of this is a nuclear-cratering experiment.
2. A nuclear test in which some radioactivity is inadvertently and unexpectedly released to the atmosphere.

In brief, the approach for the type 1 situation is to establish stations in the downwind fallout pattern. Air samplers, fallout trays, film badges, lactating dairy cows, and dairy-cow forage of various types are located at these stations. Subsequent to the test, environmental surveys are made of each station. Many different types of samples are removed and analyzed for radionuclides. Air uptake of radioisotopes by lactating dairy cows in the fallout pattern is studied by measuring the secretion of radionuclides in their milk. The contaminated forage is removed from the area, transported to our dairy barn, and fed to different groups of experimental lactating cows. Radioactive uptake from the contaminated forage is also studied by measuring the secretion of radionuclides in milk. Quantitative relationships are then established for forage to milk radionuclide ratios, time after beginning ingestion of contaminated forage for the radionuclide concentrations to reach a peak in the milk, disappearance rate of the radionuclides from the milk after the peak has been reached, and the integrated percentage of the radionuclides ingested on the forage which subsequently appears in the milk.

The approach for type 2 situation involves organizing an "after the fact" study at one or more existing dairy farms in the downwind fallout pattern. The exact nature of the study, in this case, is a strong function of the extent of cooperation which can be established with the dairy-farm managers. An attempt is made to determine the same relationship among air-forage-milk as is done in the type 1 approach.

In addition to the studies described above, for which the radioactivity is derived from actual field nuclear debris, we also design and conduct controlled releases of radionuclides over growing forage crops at our own experimental farm. In general, these studies correspond closely to those of type 1 above. It is expected that by July 1969, for a known source of radioiodine and known meteorological conditions, we will be able to predict the average peak levels of radioiodine to be found in the milk of dairy cows maintained in the downwind trajectory to an accuracy of a factor of two at the 90-percent confidence level.

In order to accurately evaluate and interpret data obtained from various field and laboratory experiments, it is mandatory to have complete background data on all experimental dairy animals. Necessary background data include individual daily milk production records, individual health, breeding, lactation, and calving records. In addition, proper feeding and milking schedules must be maintained. These data are then used to aid in the effort to simulate normal dairy-farm practices for a typical commercial dairy operation in Southern Nevada.

The scope of this report is limited to the dairy-cow facilities, dairy-cow husbandry, veterinary medicine, and experiments in which the dairy cows have been utilized.

II. USPHS EXPERIMENTAL FARM FACILITIES

A. DAIRY BARN, AREA 6, NTS

Seventeen grade Holstein cows were purchased at a dispersal sale in Idaho in the spring of 1964. A dairy was established under the supervision of the U. S. Army Veterinarian assigned to the Off-site Animal Investigation Project, AEC/NV00. No experienced milkers were available at the time thereby necessitating the employment of the cowboys originally assigned the husbandry of the AEC beef herd. No records of any kind are available to us for the dairy herd during this period.

On May 22, 1964, AEC/NV00 transferred the responsibility of the dairy and beef husbandry to the Bioenvironmental Research Program, SWRHL. Initially it was not possible to obtain qualified personnel to conduct the husbandry required for a dairy herd. As qualified livestock personnel were acquired, the dairy husbandry improved immensely. In order to establish uniform care of the dairy cows, a Standard Operating Procedure, FSS-SOP-1, was established (Appendix I). This SOP, with minor variations depending on the type of research project being conducted, still remains in effect. The dairy operations were initially conducted at Well 3, Area 6, NTS, in two Butler buildings joined to form an L. One wing was utilized as a holding pen, maternity stall, and storage area; the other contained six stanchions and a milk room. An attempt to keep the inside temperature within reasonable fluctuations failed, as the buildings were not adequately designed for an experimental dairy. Between May 22, 1964, and May 16, 1966, the building and corrals were modified in an attempt to develop a research facility that met the experimental requirements. All modifications were designed and built in such a manner that the facility could be economically converted at a later date to serve other needs, as required. However, in emergencies it could still be utilized as a milking area.

B. MILKING AND METABOLISM LABORATORY, AREA 15, NTS

Because an extensive research effort was to be devoted to the passage of radioiodine through the human food chain, and because this research was to be conducted under field conditions, an experimental farm facility was required.

The NTS, with its sources of radioactive materials resulting from various nuclear detonations and tests, seemed to be an excellent area in which to develop an experimental farm. The original concept of the farm included about 30 acres of irrigated land, facilities for a 24-cow dairy herd and a laboratory building. Further details for criteria of site and farm land may be found in SWRHL-36r. The permanent milking and metabolism laboratory was completed during spring of 1966 at Well UE-15D, Area 15. Ancillary facilities for veterinary medicine and animal husbandry remain at Well 3.

The laboratory, which is a combination milking and metabolism facility, has a four-stall milking area, a milk wash room, metabolism area, small animal room, bioelectronics laboratory, meteorological telemetry room, and a data reduction area. Because the scope of this report deals only with the dairy herd, milking facilities, and equipment necessary to maintain the herd, ancillary experimental facilities will not be discussed further.

On May 16, 1966, the lactating dairy herd was moved from Well 3B, NTS, to the new Area 15 facility (Figure 1). The milking area consists of four metal interconnected yoke stanchions. Each stanchion is widely separated to prevent cross contamination between cows being milked. Custom-built grain feeders were designed and fabricated by the dairy personnel (Figure 2). The feeders were built to prevent spilling of grain or other types of feed that may be used during an experiment. Another feature not readily obvious is the built-in privacy for each

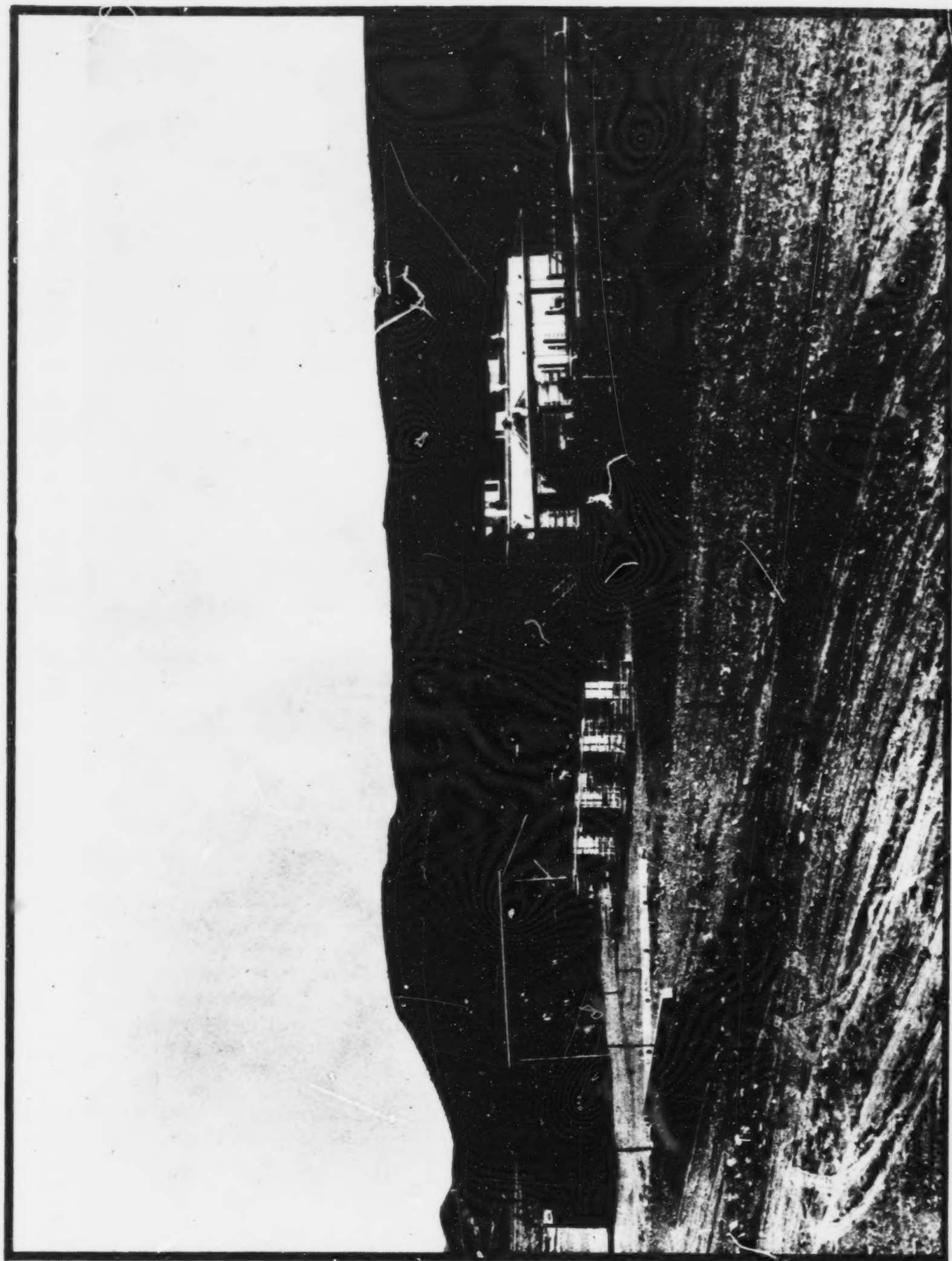


FIGURE 1 Area 15 experimental farm building complex, October, 1965.

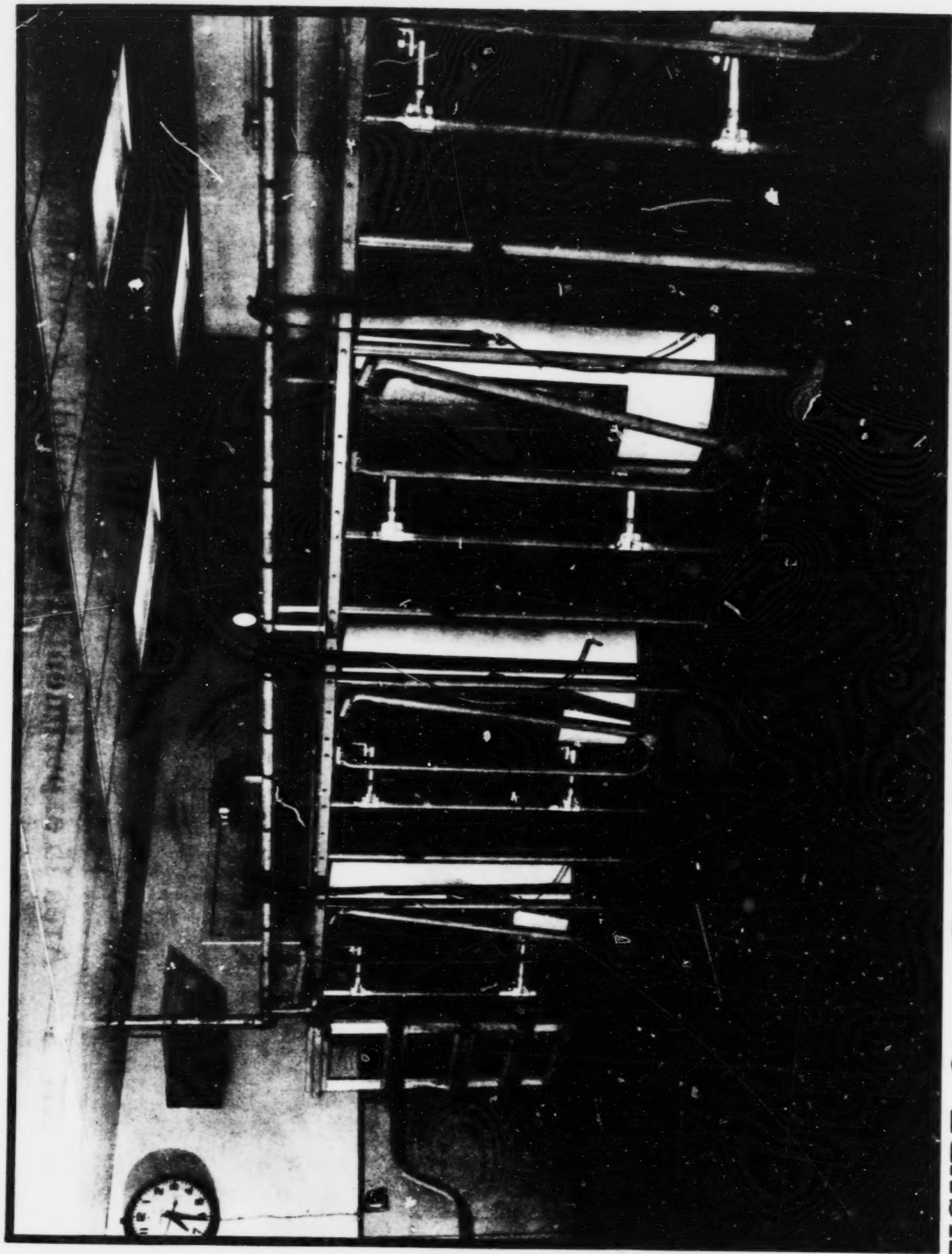


FIGURE 2 Custom built grain feeders which facilitate decontamination and feeding procedures.

cow within the feeder area which results in less anxiety during unusual disturbances.

Surge¹ bucket milkers are used. The system is composed of a stainless steel milking bucket with standard claws consisting of shells, flat dome inflations and pneumatic pulsator (Figure 3). The bucket is hung over the cow's back with a surcingle and is connected to the vacuum line by use of a hose and pulsator activator. There is no absolutely correct speed for operating a pulsator on any given herd of cows, as no two cows are exactly alike. Therefore, and because of the fast and unusual circumstances under which our cows are milked during field experiments, we use an adjustable pulsator speed selector. Vacuum is obtained by using a Surge¹ SP-22 vacuum pump attached to a 1-h.p. electric motor. The vacuum level is controlled by a Surge¹ liquid-cushioned vacuum control. Proper control of the vacuum is necessary for fast, safe, and efficient milking.

Corrals and loafing areas are fenced with cables, which are easily maintained. The cables are run through 6 x 6 wooden posts and attached to corner posts by 3-inch-diameter heavy-duty springs, which maintain tension on the cables.

Additional pen areas are constructed according to the specific requirements set forth in a particular experimental protocol. The areas, whether in the existing corrals or in areas outside, are built by using monofilament wire attached to an electric pulsator. Because cows are very respectful of electric fencing, separation of groups of cows on experiment is possible with a minimum amount of labor.

A permanent truss-supported sunshade is used to cover the stored hay and feed bunks (Figure 4). It also covers enough area of the corral to partially protect both hay and animals from adverse weather and direct sunlight. To offer more protection to animals from the summer sun, a large two-pole-supported sunshade is located in the center of the corral (Figure 5). There is a very definite need for a sunshade to maintain milk production during the extremely hot summer months. Electrically heated

¹Surge[®] equipment is manufactured by the Babson Bros. Co., 2843 W. 19th St., Chicago, Illinois.

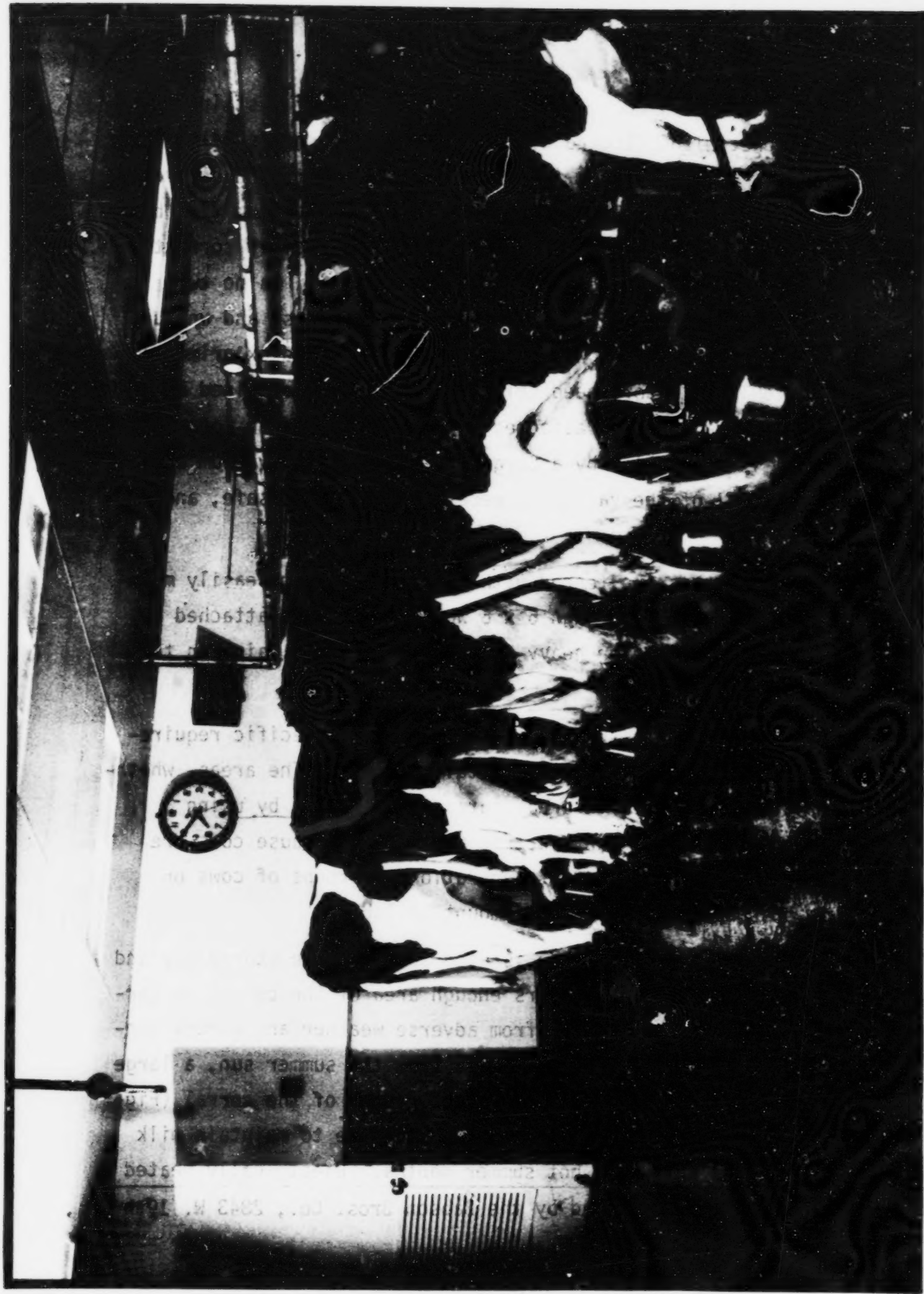


FIGURE 3
Typical milking scene with the Surge milking buckets and cows in place.

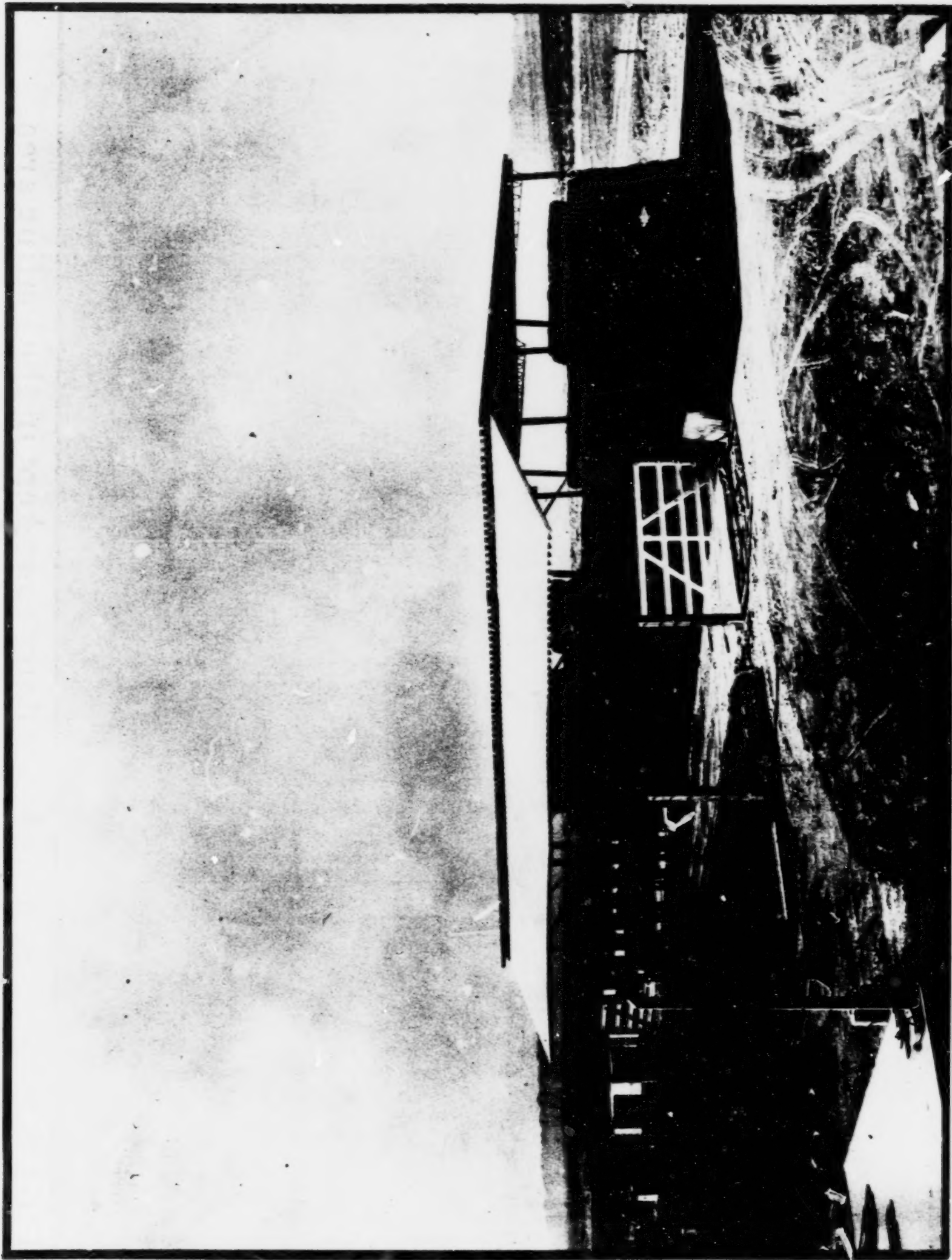


FIGURE 4 Covered hay storage area and feed bunks which protect hay and animals from the direct sunlight.



FIGURE 5 Sunshade for dairy cows kept in the loafing area.

water tanks which prevent freezing of the drinking water are used in all corrals.

III. ANIMAL HUSBANDRY

A. BACKGROUND

Of the initial 17 grade Holstein cows purchased by the AEC, eight are still in the dairy herd. Eighteen additional Holstein cows have been purchased from several different sources and added to the original AEC dairy herd, hereafter referred to as the USPHS dairy herd. Out of the original 17 cows and the 18 cows that were purchased, 12 have been culled, sacrificed, transferred to other governmental agencies, died, or are being used as nurse cows (Appendix II).

The dairy herd consists of 12 registered and 11 grade Holstein cows. The herd is now typical of herds found in Southern Nevada and the Great Basin States. This was our intention at the beginning of the project.

B. NUTRITION

Our cows, like most dairy herds in the Great Basin States, are maintained in a dry lot. They are never allowed to graze on pasture or range of any type. The main roughage is high-quality baled alfalfa hay which is supplemented with fresh alfalfa green chop when available. Alfalfa hay is fed free choice twice daily at the rate of approximately 35-40 lbs. per cow per day.

Adams Feed Co., Las Vegas, Nevada, supplied the hay during the first year of our dairy operation. This hay was grown in the Amargosa Valley approximately 30-40 miles southwest of the Nevada Test Site. Since the hay appeared to be of such high quality and as other priorities existed, no nutritional analysis of this hay was obtained. However, because it was so exceedingly fine and leafy, various degrees of tympanites were frequently observed in the animals. The hay contract covering the

period, April 1, 1965 to March 31, 1966, was awarded to Tex Gates Saddle and Feed Co. of Las Vegas, Nevada. The current contract for the period of April 1, 1966 to March 31, 1967 was let to Ence Brothers Feed and Trucking Co., St. George, Utah. Hay delivered under both contracts was grown in the Enterprise area of Utah. It was high quality and contained sufficient fiber. No signs of tympanites have been observed from feeding of this hay.

Samples taken from each shipment of hay were analyzed by Morse Laboratories² for various nutritional constituents (Appendix III). Selected constituents are presented in Table 1. A statistical analysis was done to see whether selected nutritive values were equal in all shipments. A randomized block design was used to analyze the data. The values were blocked on nutritional components, and the times of shipments were handled as treatments. The nutritional components of alfalfa hay were found not to differ significantly between shipments.

Table 1. Selected Nutritional Components of NTS Hay

DATE	MOISTURE	FIBER	PROTEIN	DIGESTIBLE	TDN
				PROTEIN	
20 Aug 65	10.32%	24.76%	16.83%	----	51.40%
3 Nov 65	8.64%	22.71%	16.80%	15.80%	54.60%
14 Jan 66	10.50%	23.21%	16.66%	14.93%	52.12%
25 May 66	7.64%	25.90%	15.15%	14.30%	52.60%
25 Jun 66	8.56%	27.40%	17.39%	13.43%	51.20%

In addition to alfalfa hay, fresh green chop has been supplied to the cows periodically. Usually this green chop has been furnished in connection with an experiment. However, as the farm becomes more and more productive, it will be provided on a routine basis during the growing season as well as during periods of an experiment. It has been fed in the morning at the rate of 10-15 kg/cow/day in the green chop manger (Figure 6).

²Morse Laboratories, 316 16th St., Sacramento, California.

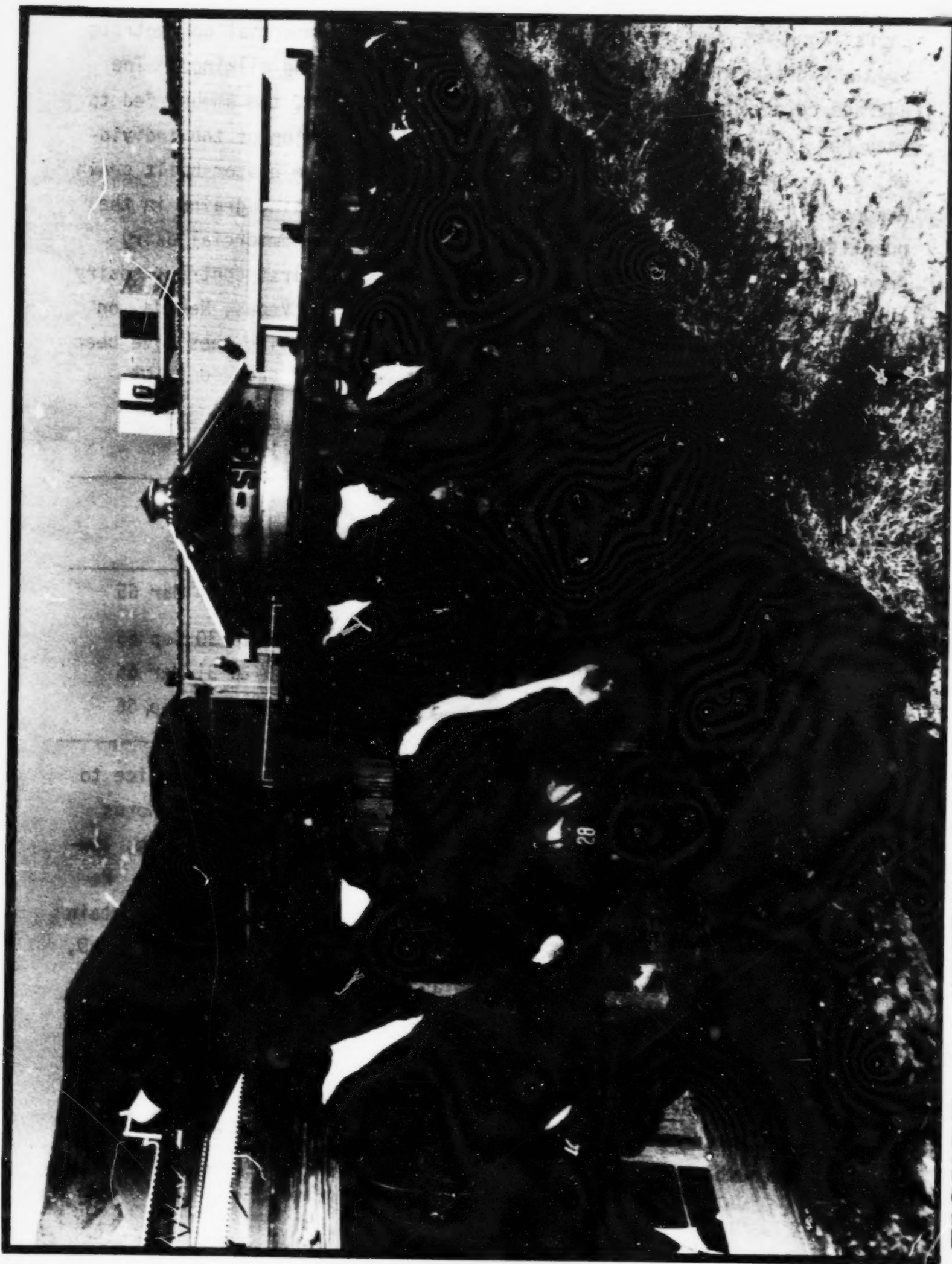


FIGURE 6 USPHS dairy cows in stanchioned feed bunks
used for feeding green chop.

Lactating dairy cows receive a 16-percent-protein commercial concentrate supplement (Appendix IV) during the morning and evening milkings. The average herd consumption is 16 lbs./cow/day. However, the amount fed to each cow is proportional to the level of milk production of the individual cow. The supplement is measured and placed in the custom-built grain feeders (Figure 2). Because of the difficulty of raising grains in the quantities necessary to maintain an adequate supply, commercial dairy feed is purchased from local sources. Prior to the first contract, dairy supplement was purchased from Adams Feed Company, Las Vegas, Nevada, on a petty-cash basis. The first contract and all succeeding ones have been for a period of 6 months. Table 2 lists the period of each contract.

Table 2. List of Suppliers of Dairy Feed Supplements

Name of Supplier	Commercial Name of Supplement	Period
Tex Gates Feed Co.	Purina	22 Sep 64 to 31 Mar 65
Clark County Wholesale Mercantile Co.	Pillsbury	1 Apr 65 to 30 Sep 65 1 Oct 65 to 31 Mar 66 1 Apr 66 to 30 Sep 66

As on a typical dairy farm, trace mineralized salt is fed free choice to all dairy cows. This geographical area is extremely low in phosphorus and high in calcium. Because of this fact, special high-phosphorus, low-calcium mineral supplement (Appendix IV) is also given free choice. We have found by experience, although the mineral supplement and hay contain enough Vitamin A., that the supplemental administration of Vitamins A, D, and E results in better milk production and a stronger calf crop.

C. IDENTIFICATION OF DAIRY COWS

Number 1 through 499 have been reserved for the dairy herd. Each addition to the herd--either by purchase or birth--is issued the next consecutive number without regard to sire or dam thereby using no number

more than once. When an animal is removed from the herd, regardless of cause, its number is permanently retired.

Initially our cows were identified by the use of ear tags in each ear. Because of the tendency to lose the tags as well as poor readability, standard neck chains with white embedded plastic numbers in a black plastic material replaced the ear tags. These have been fairly successful; but there is still some difficulty in observing the number, especially when the animal is in the milking stall or when facing in the opposite direction from the observer. To supplement the use of the neck chains, we developed a variation of cryogenic branding which utilizes liquid nitrogen instead of alcohol and dry ice. Briefly, the procedure consists of immersing 3-inch copper branding irons in liquid nitrogen for 3 minutes, then applying the iron for 30 seconds on a black area of the right hip, which has been dampened with 70-percent alcohol.

If application is properly done, white hair replaces the original black in approximately 60-90 days, which results in a clearly visible brand. If the iron is held in place for a longer period of time than 30 seconds, the resulting scar is similar to that produced by heat. The use of cryogenic branding plus the neck chains is a very good identification system for our purpose.

As a back-up system in young animals, a permanent identification is provided by tattooing each animal's assigned number in its right ear. This is accomplished as soon as possible after birth to eliminate possible confusion of parentage. Branding and neck chains are applied at the convenience of the livestock personnel. Each calf is accounted for regardless of its disposition (Appendix V).

D. RECORDS FOR DAIRY HERD

Each adult animal has an individual file which contains two permanent records. The first is an American Breeder Service form which provides space to record information on health, reproduction, production, vaccinations, identification, genealogy, and transfers (Appendix VI). A color

photograph of each animal is attached to the form for identification purposes. The second record is the individual record system as used by the Dairy Herd Improvement Association (DHIA). This form duplicates in part some of the information found on the American Breeding Service form, but provides a current record of production, butterfat, and management. Each month a current strip is attached to the card. The Dairy Herd Improvement Association also provides a monthly summary of herd production for that month and a monthly summary of herd production for the previous 12 months. A sample DHIA Card is shown in Appendix VII. Information received consists of: daily milk and butterfat production, individual grain recommendations, days pregnant and days open, extrapolated 305-day records, relative value to herd average, and management notes. Other data listed include length of previous dry period, date of birth, calving date, age at calving, and lactation number. In addition to maintaining these two permanent records, milk production, feed consumption, reproduction, medical treatment, work requirements and accomplishments, and events affecting the dairy herd are reported on a daily basis. This information is summarized and tabulated as a monthly report. A complete and separate file is maintained during each experiment involving the dairy herd. Data recorded include individual production, individual feed and water consumption, weather conditions, numbers and types of samples collected, and the detailed experimental protocol.

E. MILKING PROCEDURES

While it is realized that dairy cows are not "machines" and therefore cannot be operated as such, a routine has been established for the dairy personnel to insure consistent techniques in all phases of dairy husbandry. Because of the nature of the USPHS dairy operations on the NTS and the scheduling of AEC activities in the experimental farm environs, the milking schedule is the least consistent of any other phase. Whenever possible, the cows are milked two times daily. Normally, there is a 15-hour interval between P. M. and A. M. and a 9-hour interval between A. M. and P. M. milkings. Adjustments in this schedule have not

interfered with the overall yearly milk production of the herd. For a detailed description of the day-to-day milking and feeding procedures, the reader is referred to the FSS-SOP I found in Appendix I.

During experiments that utilize milk from the cows, individual milking buckets for each cow are used to minimize the possibility of cross contamination (Appendix VIII). Each cow is milked with a separate Surge¹ bucket and claw that is marked with her identification for the particular experiment. This equipment is never used on any other cow for the duration of the experiment. Normally the cows are milked as they choose to enter the barn. However, during experiments, the milking order is arranged so that control cows are milked first, followed by those with the lowest radionuclide burden and progressing until the last cows milked are those with the highest radionuclide burden.

In our operation, milk sampling is a matter of routine and therefore must be included in a discussion of milking procedures. Sampling techniques have been standardized so that each milk sample is collected, handled, and recorded in the same manner. Other than routine weekly collections, the protocol for the experiment of concern will establish the number, type, and time of milk collections. Each sample is collected by pouring the milk directly from the milking bucket into a Cubitainer,^(R)³ or a covered container. The type of container and its contents will depend on whether the samples are on an individual or composite basis. Normally all milk samples are preserved with 37-percent formaldehyde, but on occasion no preservatives are added to the milk. For more detail of each procedure, the reader is referred to FSS-SOP-2 (Appendix VIII).

On the last day of the month, milk from each cow is collected in a "Whirl-a-bag"^(R)⁴ and preserved with potassium dichromate and submitted to the Virgin Valley Dairy Herd Improvement Association, Mesquite, Nevada. The day's production for each cow and other pertinent data are submitted with the samples.

³"Cubitainer" is mfg. by Hedwin Corp., 1209 E. Lincoln Way, La Porte, Ind.
⁴"Whirl-a-bag" is mfg. by NASCO, Fort Atkinson, Wisc.

F. VETERINARY MEDICINE

1. Mastitis

As is true for most commercial dairies, our major veterinary problem has been mastitis. The complexity of the etiology of the disease makes solution of the problem dependent upon (1) critical diagnosis of the specific microbial agent involved, (2) correction of faulty managerial practices, and (3) judicious use of drug therapy. Incidence of mastitis in individual cows is listed in Appendix IX. Methods for the detection of mastitis consist of physical, chemical, or microbiological tests applied to the udder or milk. Physical tests include palpation of the udder, temperature, physical examination, and use of the strip cup. Prior to applying the milker, two to three free-flowing streams from each teat are squirted into the strip cup. Any abnormal finding is classified as mastitis. Chemical tests are limited to a monthly California Mastitis Test (CMT). Samples from individual quarter milk are prepared according to standard procedures. If the test is positive; i.e., if the leukocyte count is above normal, the affected quarter is assumed to have mastitis. Microbiological tests per se are not done. However, antibiotic sensitivity tests are done if the affected quarter has to be treated.

All suspects are treated as cases of acute mastitis. Depending on the sensitivity tests and prior history, the drug of choice is infused into the affected quarter following each milking for no less than six treatments. Additional treatment is given as indicated. This may be parenteral antibiotics, fluid therapy, diuretics, hormones and/or rumen stimulants, depending on the clinical response. Spread of mastitis from infected cows to healthy cows is reduced by using separate milking buckets, isolation of cows, prevention of spilling of infected milk on floors, disinfection of teat cups, and other methods usually employed in strict sanitary programs.

When a cow with a history of mastitis is dried up, 30 cc of Furacin[®]⁵ is infused into each quarter. This is repeated 4-6 weeks prior to parturition. By following this method religiously, the incidence of mastitis has been reduced considerably.

⁵Furacin is manufactured by Eaton Laboratories, Norwich, New York.

2. Metabolic Disturbances

We have had two cases (Cows 24 and 46) of parturient paresis (milk fever) following parturition. Both animals responded to the standard treatment of intravenous infusion of 500 cc calcium borogluconate. Ketosis has not been observed in our herd even under the most stressful conditions, such as those experienced during field experiments. This is in part due to the high protein feeding regime employed throughout the period of experimentation.

3. Digestive Disturbances

Tympanites (bloat) was a problem in cows consuming damp sixth-cutting alfalfa. Apparently this hay did not have sufficient bulk to stimulate eructation as one might expect. We lost two cows (Nos. 8 and 20) during this period and successfully treated several other animals before the exact cause could be determined. A new source of hay was found, and to date no further deaths from bloat have occurred.

We have diagnosed two cases of acute traumatic gastritis--Cow No. 11 in October 1965 and Cow No. 1 in May of 1966. Ironically, both of these cows were animals that had been used in a field experiment and therefore were of extreme interest to the research program. Cow No. 11 was treated on a symptomatic basis with wide-spectrum antibiotics, electrolytes, rumen stimulants, and magnets. A rapid recovery was apparent, as milk production returned to near normal. No relapse has been observed or suspected. Treatment of Cow No. 1 was not successful. Numerous exacerbations and remissions of the cardinal signs of traumatic gastritis occurred following treatment with various drugs. Surgical intervention (rumenotomy) was done in an attempt to remove the object causing the condition. The magnet and metal objects as well as a long piece of baling wire were removed via a rumenotomy incision. The animal made an apparent recovery, which lasted for approximately two weeks; then a remission of symptoms occurred. The animal died on June 11, 1966. Abscesses were found in every organ of the body. Cause of the condition was a matter of conjecture and will not be discussed further. For more

complete necropsy findings and surgical approach, see section on Veterinary Surgery.

Because prevention of traumatic gastritis is more important than the medical or surgical treatment of the condition, we now routinely emplace rumen magnets in all our dairy cows. This, for the most part, prevents the penetration of metal particles into the abdominal or thoracic cavities. In addition to this, there has been a concentrated effort to strip lots and mangers of any pieces of baling wire or other metal objects that could possibly be ingested. Care is taken to prevent wire being inadvertently placed in the hay manger. Awareness of this problem by various research and nonmilking personnel has resulted in decreased amounts of extraneous metal objects in the area.

4. Calf Scours

Diarrhea (scours) in newborn animals has been a minor problem. Investigation of each case revealed that overfeeding caused most of the digestive disturbances. To reduce intake and the tendency for the livestock personnel to overfeed the calves, the quantity of milk given to each calf was adjusted to not exceed 10% of body weight per day for the first few weeks of the calf's life. If scouring does occur, medical treatment is initiated immediately. Treatments usually consist of a combination of broad spectrum antibiotics, antidiarrheal compounds, and oral electrolytes.

5. Enterotoxemia

Diagnosis of enterotoxemia is usually made on the basis of lesions found at autopsy and on laboratory culture results. In the two deaths (Calves 52 and 56) diagnosed as being due to enterotoxemia, overfeeding was determined to be the inciting cause. This condition has been controlled by strict adherence to the rule that milk feeding should not exceed 10% of body weight and by a program of inoculations of pregnant cows with enterotoxemia vaccine.

6. Veterinary Surgery

a. Teat Surgery. Teat surgery has consisted of removal of lacteal calculi, repair of contracted sphincters, removal of tumors, and repair of teat lacerations. All animals have responded well to the surgical procedures and have, in all instances, returned to full milk production.

b. Hoof and Foot Surgery. At the time of our assumption of responsibility of the dairy herd, all cows had malformed hooves and were suffering from lameness and interdigital ulcerations. For the most part, extensive surgical treatment was necessary. The hooves were trimmed to proper configurations, necrotic areas were curetted and cauterized, and interdigital ulcers treated with astringent agents. The animals were placed in large exercise lots for at least 2 weeks until healing took place. This regime has successfully eliminated most of the foot problems and only occasionally is it now necessary to do hoof surgery.

c. Abdominal Surgery. On November 30, 1964, Cow No. 4 suffered a penetrating abdominal wound when she ran into a tractor-mounted manure fork. The wound was cleansed, debrided, and sutured. Broad spectrum antibiotics were given for 1 week. The animal made an uneventful recovery.

On June 1, 1966, an exploratory laparotomy and rumenotomy were performed on Cow No. 1. A penetrating wire and massive adhesions from the reticulum to the pericardial sac were found, and a rumenotomy was then done. A tenpenny nail, 7-inch piece of baling wire, and several smaller pieces of wire were removed from the reticulum. Despite the surgical removal of the inciting cause and extensive supportive treatments, death occurred on June 11, 1966. An autopsy revealed vegetative valvular endocarditis of the right atrioventricular valve, multiple abscessations of liver and lungs, a large abscess in the spleen, and peritonitis.

d. Experimental Surgery. An experimental rumen gas-collection cannula was surgically implanted in Calf No. 40 on March 16, 1966. The cannula had an airtight rumen-skin seal and was healing normally until the cannula was caught on a fence and torn free from the skin and rumen. Replacement was not possible without further surgical intervention. However, at the time, replacement was not feasible so the incised area was treated as an open wound. Recovery was uneventful.

7. Routine Blood Examinations

Because blood reflects the physical state of the body, certain biochemical tests and whole blood counts are taken on a monthly basis. On occasion, as during periods of an on-going experiment, the frequency of such tests is increased to meet the criteria of the experiment. Once each month, 30 cc of whole blood is withdrawn from the external jugular of all dairy cows. Five cubic centimeters of the blood are put in a glass vial containing anticoagulant. The remaining blood is put in glass vials for serum collection. The whole blood is submitted for complete blood counts which include determinations for red blood cells, and a differential count. The serum is submitted for total protein (TP), protein bound iodine (PBI), and T_3 .

G. DISCUSSION

The acute episodes of mastitis, which appear in many dairy herds, have been minimized. The first problem period in our herd occurred in June and July of 1964 before we had adequate facilities and competent personnel. This outbreak was apparently caused by poor milking techniques used by inexperienced employees. The establishment of the FSS-SOP-1 for standard dairy methods resulted in an improvement in sanitation. This improved procedure and intensive medical treatment brought the mastitis under control by September.

The second period occurred in April of 1965. The precipitating cause was determined to be the stress of a field experiment complicated by heavy snows and rains that turned the barn lots into quagmires. All

cows promptly responded to treatment following the return of sunny weather and the termination of the experiment.

The third episode occurred in March of 1966. This outbreak did not involve as many cows as the others, but was more difficult to correct. It was precipitated by a combination of muddy lots and defective milking equipment. All rubber parts of the existing equipment were replaced and the vacuum system checked over. With the increased use of the California Mastitis Test as an indicator for chronic inflammation and specific medical treatment, the outbreak was gradually brought under control.

The incidence of mastitis on a herd basis, as shown in Figure 7, was 7.2% for the first 4 months of operation. Control measures have reduced the incidence to 1.7%. Some cows are more prone to mastitis than others. In some cases, this may be explained by heredity, anatomical defects, temperament (nervous cows are more prone to injury), and presence of scar tissue from previous episodes of mastitis. Because of this, cows are culled if they have any one of these features, thereby keeping mastitis to a minimum.

Although no accurate records are available for the AEC dairy herd prior to the transfer, it would be safe to assume that the May 1964 average milk production of 27.8 lbs. per cow was within the normal limits for the herd at that time. It was not until September of 1964, that the herd milk production started to rise (Figure 8). This, no doubt, was a combination of many factors, such as reduction of mastitis, improved veterinary care, better management, new milking equipment, and better husbandry practices. A large number of the cows were being milked beyond the normal drying-off time, which accounts for the high percentage of herd in production in May 1964 (Figure 9). When new management procedures were initiated, the cows were dried up at the recommended time of 305 days. This action resulted in a larger percentage of the herd being removed from the milking string. The logistics of one experiment made it impractical to have the cows bred during late March, April, and early May of 1965. This is reflected by a low number of cows in the production for January and February 1966.

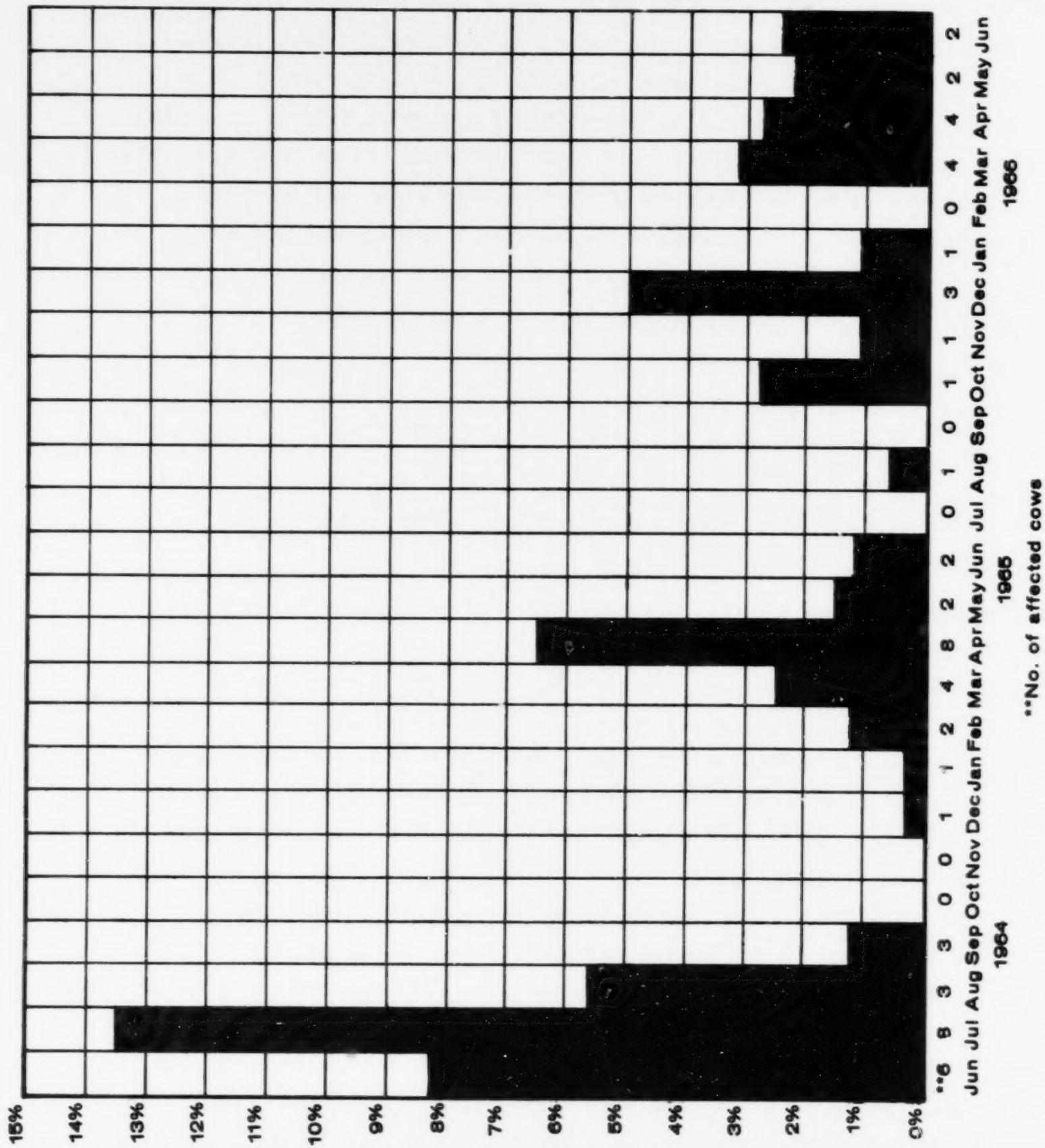


FIGURE 7

Mastitis Incidents UHPHS Dairy Herd

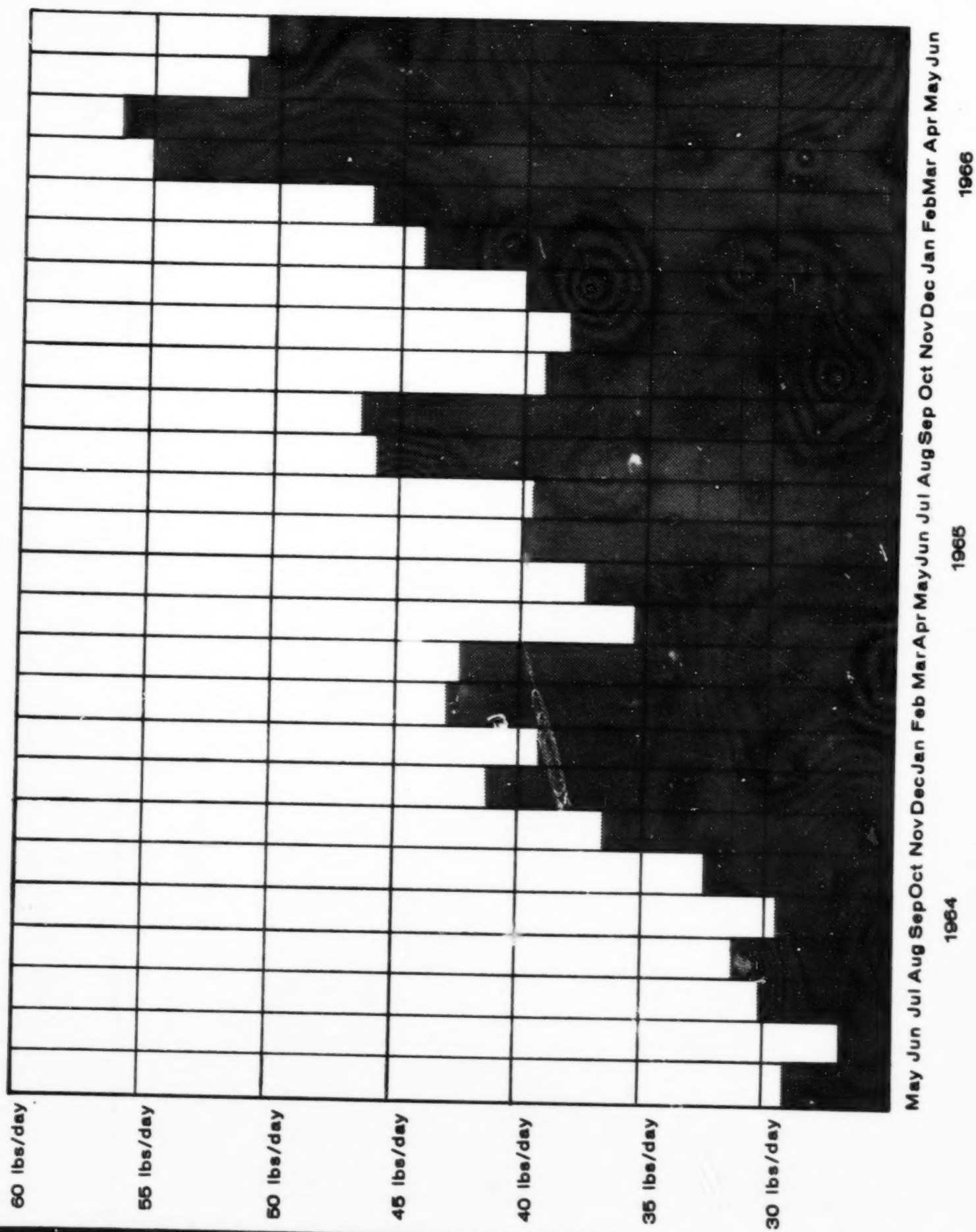
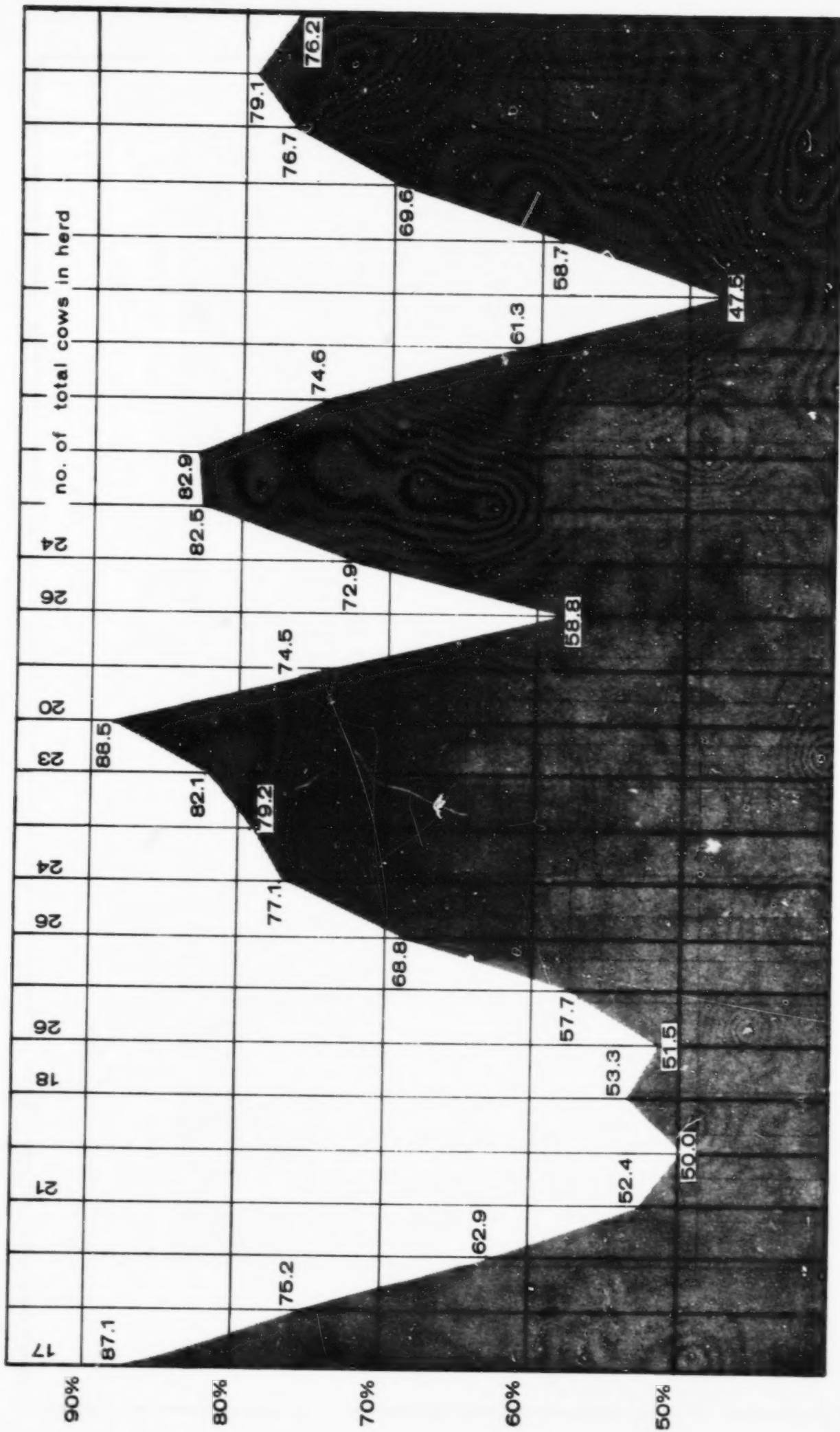


FIGURE 8
Average Milk Production, (per cow, per month)



*14.8 12.8 10.7 11.0 10.5 9.6 13.4 15.0 17.9 17.9 17.9 18.5 19.0 18.9 17.7 14.9 15.3 17.5 19.8 19.9 14.7 11.4 14.1 16.7 18.4 19.0 18.3
 May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun
 * no. of lactating cows 1964 1965 1966

FIGURE 9
 % of Herd in Production per Month

The improved 305-day milk average is a reflection of the reduced mastitis incidence and increased management efficiency. Our average per cow, as computed by adjusting the DHIA results, is 12,906 lbs. or 5,866 liters (Appendix X). The average butterfat per cow for this reporting period was 439 pounds. The Holstein-Friesian Association of America reports the following production figures based on a twice-a-day-milking, 305-day, mature-equivalent average of all reported DHIA records, 1956-1959.

<u>Holsteins</u>	<u>Milk (lbs.)</u>	<u>Butterfat (lbs.)</u>
Registered	12,560	460
Grade	11,567	424

The Washington County, Utah, Dairy Herd Improvement Report of November 1965 lists the following figures:

Number of Herds	8
Cows per Herd	84
Average lbs. of Milk	12,241
Average % of Fat	3.5
Average lbs. of Fat	433

It is apparent that the herd compares quite favorably to the milk production for other commercial dairy herds. The average milk production per cow for each month since May 1964 is graphically presented in Figure 8. There is a cycle of high production occurring twice each year. In general, peaks in milk production occur during the February-April interval and the August-September interval. The lowest production occurs 1-2 months after the peak and thereafter takes 3-4 months to again peak.

The butterfat content of the milk is directly affected by heredity and the type of feed. The erratic results in the herd (Figure 10) are due, in part, to a large percentage of animals being on field tests and on different types of feed; e.g., green chop and hay, green chop only, or hay only. However, at this time the type of tests and the methodology is questioned, as the butterfat production is not consistent throughout the year. In order to test validity of the DHIA butterfat results, it is planned

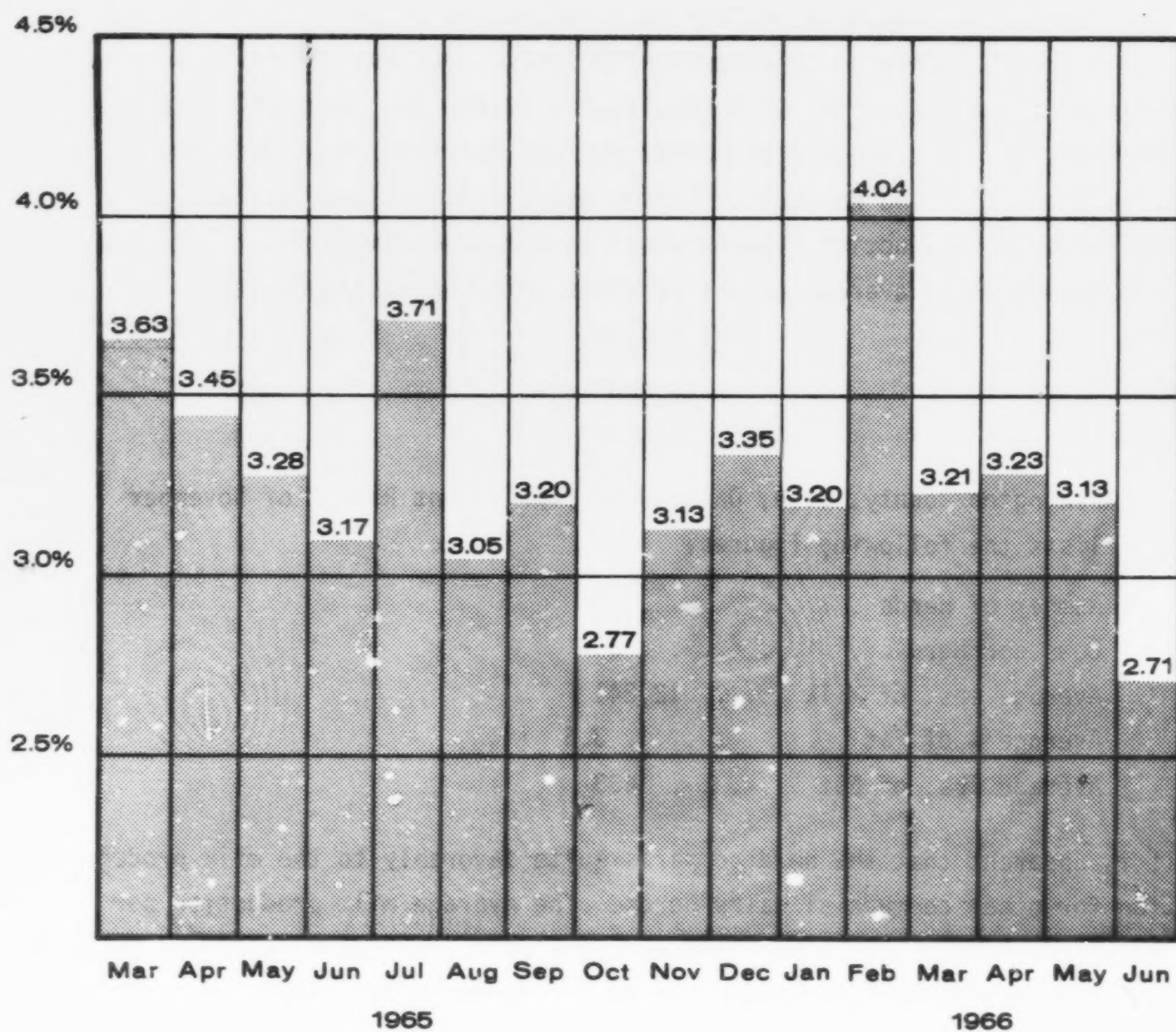


FIGURE 10
Herd Average Butterfat %

to institute a system of submission of duplicate samples. If results are not consistent, we will institute our own testing program.

Changes observed in total proteins of blood serve only to indicate the status of the subject under study at that particular time. Many disease conditions and other physiological or artificially induced factors produce similar changes in the plasma proteins. The observation that an abnormality exists in the plasma proteins indicates that some pathological, physiological, or induced factor is causing the condition. Because there appears to be a wide divergence in the acceptable normal data, it was considered mandatory that values be established which are accepted as a normal range for the dairy cows (Table 3). Total protein of blood serum appears to be not only dependent on physiological or pathological factors, as three distinct seasonal peaks occurred in our herd. The first peak occurred in the April-May interval. It is difficult to estimate the significance of this because the herd was involved in a field experiment. The second peak occurred October-November, although not as high as the first peak. The third peak was very similar to the second peak in magnitude and occurred during the April-May period. Very definite troughs are observed during the July-August and November-February intervals.

As the reader will recall, the dairy herd is used to study the transport of radionuclides, especially radioiodines, through the ecological system. Iodine accumulation in the cow, and therefore secretion in the milk, is not independent of thyroid function. Many of the tests used in humans, such as hematology, basal metabolic rate (BMR), and serum cholesterol are unsatisfactory in animals. A direct parameter of thyroid function is the measurement of the amount of thyroxine in the blood stream. Essentially all of the organically bound iodine in the plasma is that of the thyroid hormone. Therefore a measure of the amount of iodine bound to protein (PBI) of plasma should reflect the amount of circulating thyroid hormone. The PBI varies directly with the degree of thyroid activity. As such, PBI values in cows should be interpreted with care even when they fall within the normal range.

Table 3. Average values of total protein, P.B.I., and T.B.I. for entire dairy herd except Cows 1, 2, 5, and 11.*

DATE	T.P. gm/100	P.B.I. μgm	T.B.I. Percent
1 Apr 65	7.8 ± .50	4.21 ± .46	.91 ± .04
22 Apr 65	8.2 ± .74	3.82 ± .47	.92 ± .05
4 May 65	7.6 ± .43	4.18 ± .52	.92 ± .04
11 May 65	7.8 ± .44	4.48 ± .59	.91 ± .04
18 May 65	7.6 ± .37	4.05 ± .34	.90 ± .05
16 Jun 65	7.5 ± .45	3.92 ± .73	.89 ± .04
14 Jul 65	7.6 ± .54	3.30 ± .66	.89 ± .04
11 Aug 65	7.3 ± .47	3.29 ± .60	.94 ± .06
15 Sep 65	7.5 ± .54	2.68 ± .51	.94 ± .07
13 Oct 65	7.7 ± .42	3.23 ± .74	.93 ± .05
17 Nov 65	7.6 ± .50	3.62 ± .90	.93 ± .05
16 Dec 65	7.6 ± .45	3.07 ± .55	.94 ± .04
18 Jan 66	7.4 ± .40	3.50 ± .60	.93 ± .04
15 Feb 66	7.2 ± .59	2.82 ± .40	.93 ± .05
15 Mar 66	7.6 ± .64	2.78 ± .47	.94 ± .06
19 Apr 66	7.7 ± .66	2.90 ± .63	.94 ± .06
16 May 66	7.5 ± .63	2.57 ± .60	.94 ± .06
16 Jun 66	7.3 ± .55	2.65 ± .75	.92 ± .06

*Values are $\bar{x} \pm \text{I.S.D.}$

By determining individual PBI values on a monthly basis, it was hoped to observe a seasonal trend if one occurred, and secondly, to collect enough data to determine the normal PBI ranges for the dairy herd. The seasonal variation of the PBI does not appear as dramatic as the variation in total protein. On examination of Figure 11, one generally finds a peak during the May-June and November-December periods. However, without statistical treatment and more observations over a longer period, the data are not obvious enough for accurate interpretation.

To further aid in developing normal parameters for thyroid function, the thyrobinding index was used as an adjunct to the PBI test. Circulating thyroid hormone, as triiodothyronine (T_3), has been found to be almost completely bound between the α_1 - and α_2 -globulins with essentially no binding to prealbumin proteins. These fractions are commonly referred to as thyroid-binding globulins (TBG). The status of thyroid function has been shown to be proportional to the degree of saturation of the protein-binding sites. The TBI method of directly measuring uptake on the binding sites gives a positive indication of thyroid hormone status.

Prior to August 1965, the dairy herd apparently had very high thyroid activity, as the values during this period are beyond the normal euthyroid limits. From August 1965 to May 1966, the herd was in a euthyroid state. At the present time, no explanation is possible for the hyperthyroid condition of the herd. Continued studies may shed further light in this regard.

The diagnosis of diseases of the thyroid gland in animals is often obscured by the nonspecific nature and variety of clinical signs. Total protein, PBI, and TBI tests directly or indirectly measure the thyroid activity; complete blood counts (Table 4) aid in determining the physiological status of all body tissues. The hemogram, i.e., hemoglobin, red blood cells (RBC), and hematocrit, differ from many of the values found in the literature. RBC are much lower than most published normal values, probably as the result of cellular disintegration between time of collection and time of analysis. With the development of our own laboratory facilities, blood is now examined promptly; and results are

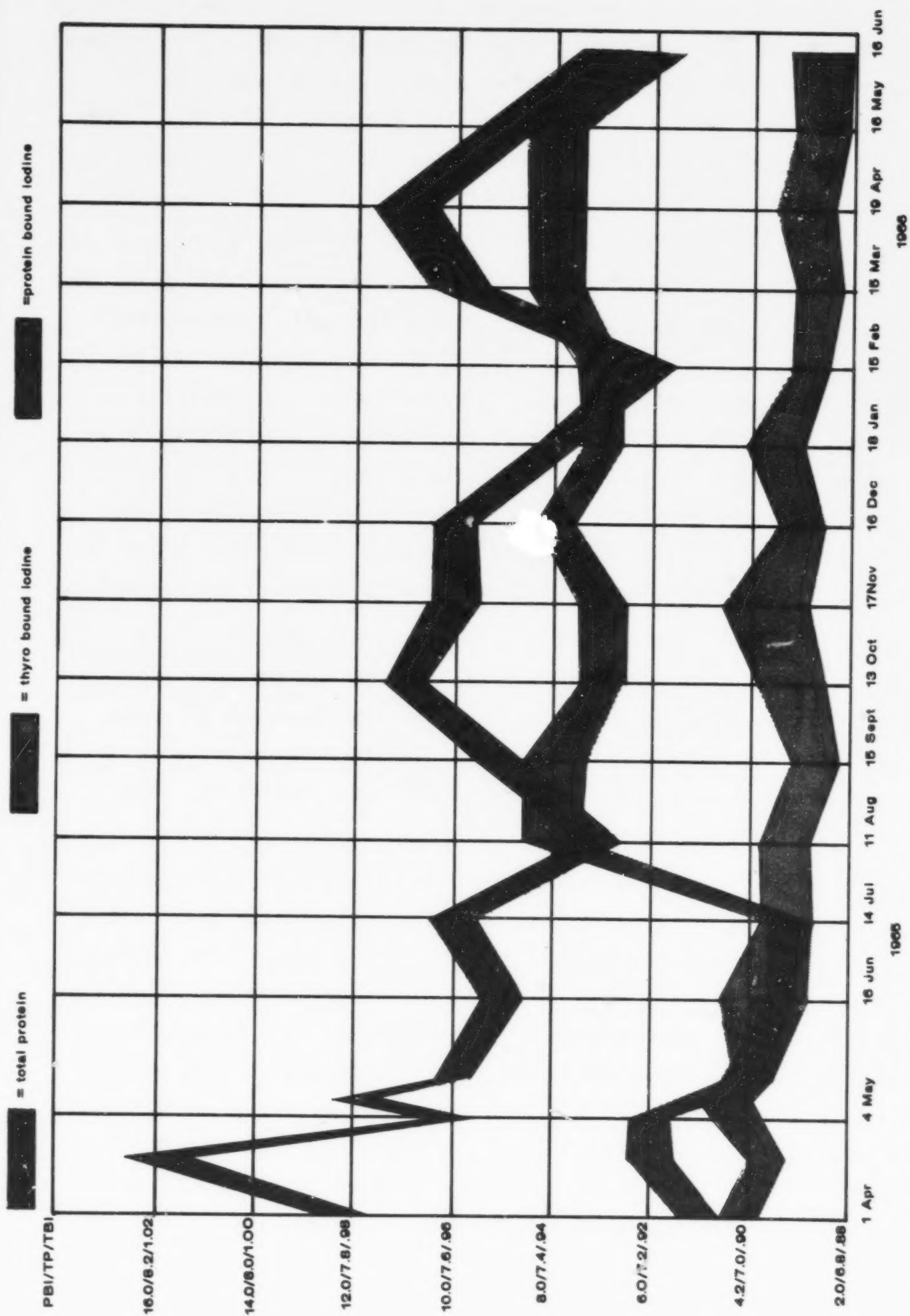


FIGURE 11
Values of TP,TBI + PBI for Dairy Herd from April 1965 to June 1966

Table 4. Average of Complete Blood Counts for Entire Dairy Herd
Except Cows No. 1, 2, 5, and 11.

DATE	HGB gms/100 cc	% HCT	RBC + 10 ⁶
4/22/65	12.0 ± 0.8	39.6 ± 2.3	4.48 ± .32
5/4/65	10.6 ± 0.7	34.6 ± 2.3	4.55 ± .19
5/11/65	11.6 ± 0.6	38.6 ± 2.8	4.57 ± .17
5/18/65	11.6 ± 0.9	39.1 ± 3.2	4.41 ± .19
6/16/65	10.4 ± 0.8	34.9 ± 2.0	4.69 ± .15
7/14/65	10.4 ± 0.5	35.0 ± 2.6	4.48 ± .23
8/11/65	10.7 ± 1.0	35.3 ± 3.5	4.67 ± .20
9/15/65	10.9 ± 0.8	35.0 ± 2.9	4.64 ± .22
10/13/65	10.5 ± 0.9	36.1 ± 3.6	4.69 ± .23
11/19/65	10.9 ± 0.9	36.2 ± 4.1	4.48 ± .34
12/16/65	11.1 ± 0.7	36.6 ± 3.4	4.67 ± .24
1/18/66	10.9 ± 0.7	36.1 ± 3.2	4.58 ± .19
2/15/66	11.0 ± 0.5	36.5 ± 2.9	4.75 ± .10
3/17/66	11.3 ± 0.8	37.7 ± 3.6	4.58 ± .20
4/18/66	11.3 ± 0.7	37.0 ± 3.2	4.73 ± .10
5/16/66	11.1 ± 0.9	36.7 ± 2.8	4.78 ± .08
6/16/66	10.9 ± 0.9	37.4 ± 2.4	4.68 ± .08

Table 4. Average of Complete Blood Counts for Entire Dairy Herd Except Cows No. 1, 2, 5, and 11.
(Continued)

DATE	WBC	EOS ABSOLUTE PERCENT	BASO ABSOLUTE PERCENT	JUV ABSOLUTE PERCENT	STAB ABSOLUTE PERCENT	SEGS ABSOLUTE PERCENT	LYMPH ABSOLUTE PERCENT	MONO ABSOLUTE PERCENT
4/22/65	8300 ± 2042	171 ± 139 2.0 ± 1.4	0 0	0 0	0 0	2993 ± 1171 35.6 ± 9.1	5130 ± 1353 62.3 ± 9.6	0 0
5/4/65	7980 ± 1880	204 ± 265 2.5 ± 3.3	0 0	0 0	78 ± 52 .9 ± .4	3370 ± 819 42.3 ± 3.8	4925 ± 1107 53.7 ± 4.5	34 ± 44 .4 ± .6
5/11/65	8963 ± 1143	171 ± 128 1.8 ± 1.3	0 0	0 0	136 ± 47 1.5 ± .5	1862 ± 441 20.6 ± 3.4	6725 ± 833 75.2 ± 4.3	70 ± 82 .7 ± .8
5/18/65	9410 ± 881	273 ± 3771 2.8 ± 3.9	0 0	0 0	0 0	2167 ± 681 23.1 ± 7.1	6944 ± 900 73.7 ± 5.8	26 ± 45 .2 ± .4
6/16/65	9550 ± 2049	161 ± 126 1.8 ± 1.5	0 0	0 0	94 ± 58 1.0 ± .5	2487 ± 796 26.4 ± 8.7	6773 ± 1987 70.2 ± 9.7	35 ± 57 .4 ± .6
7/14/65	8427 ± 1092	113 ± 81 1.3 ± .8	0 0	0 0	109 ± 62 1.2 ± .7	2332 ± 432 27.7 ± 3.8	5832 ± 849 69.1 ± 3.6	36 ± 55 .4 ± .7
8/11/65	8876 ± 901	82 ± 112 .9 ± 1.2	0 0	0 0	91 ± 70 1.0 ± .8	1835 ± 321 20.6 ± 2.8	6816 ± 740 76.7 ± 2.2	53 ± 57 .6 ± .6
9/15/65	9198 ± 505	93 ± 72 1.0 ± .7	0 0	0 0	95 ± 72 1.0 ± .8	1927 ± 306 20.9 ± 3.1	7031 ± 537 76.4 ± 3.6	62 ± 75 .6 ± .7
10/13/65	8564 ± 1039	68 ± 75 .8 ± .8	0 0	0 0	46 ± 65 .5 ± .7	2069 ± 759 23.7 ± 6.1	6356 ± 729 74.6 ± 6.5	25 ± 41 .2 ± .4
11/19/65	8776 ± 855	130 ± 121 1.4 ± 1.3	0 0	0 0	96 ± 103 1.0 ± 1.1	1952 ± 384 22.2 ± 3.8	6551 ± 787 74.6 ± 4.8	55 ± 78 .6 ± .8
12/16/65	8810 ± 1013	89 ± 73 1.0 ± .8	0 0	0 0	53 ± 64 .5 ± .6	1891 ± 287 21.5 ± 2.5	6737 ± 852 76.4 ± 3.1	40 ± 58 .4 ± .6

Table 4. Average of Complete Blood Counts for Entire Dairy Herd Except Cows No. 1, 2, 5, and 11.
(Continued)

DATE	WBC	EOS ABSOLUTE PERCENT	BASO ABSOLUTE PERCENT	JUV ABSOLUTE PERCENT	STAB ABSOLUTE PERCENT	SEGS ABSOLUTE PERCENT	LYMPH ABSOLUTE PERCENT	MONO ABSOLUTE PERCENT
1/18/66	8998 ± 557	$\frac{90 \pm 84}{1.0 \pm .9}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{119 \pm 58}{1.3 \pm .6}$	$\frac{1886 \pm 202}{20.9 \pm 1.8}$	$\frac{6838 \pm 530}{75.9 \pm 2.5}$	$\frac{66 \pm 80}{.7 \pm .9}$
2/15/66	8952 ± 592	$\frac{106 \pm 87}{1.1 \pm .9}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{71 \pm 65}{.8 \pm .7}$	$\frac{2038 \pm 265}{22.7 \pm 2.5}$	$\frac{6699 \pm 477}{74.8 \pm 2.7}$	$\frac{77 \pm 83}{.8 \pm .9}$
3/17/66	9136 ± 2350	$\frac{302 \pm 218}{3.2 \pm 2.0}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{128 \pm 132}{1.2 \pm 1.1}$	$\frac{2256 \pm 1137}{24.0 \pm 7.8}$	$\frac{6266 \pm 1361}{69.5 \pm 9.8}$	$\frac{191 \pm 194}{1.9 \pm 1.5}$
4/18/66	8874 ± 743	$\frac{248 \pm 176}{2.7 \pm 1.9}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{55 \pm 59}{.6 \pm .6}$	$\frac{3536 \pm 532}{39.8 \pm 5.0}$	$\frac{5006 \pm 663}{56.3 \pm 5.3}$	$\frac{0}{0}$
5/16/66	9008 ± 502	$\frac{169 \pm 187}{1.8 \pm 2.1}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{115 \pm 123}{1.2 \pm 1.3}$	$\frac{3453 \pm 740}{38.4 \pm 8.5}$	$\frac{5224 \pm 899}{57.8 \pm 8.4}$	$\frac{47 \pm 74}{.5 \pm .8}$
6/16/66	8474 ± 2018	$\frac{341 \pm 168}{4.0 \pm 1.8}$	$\frac{0}{0}$	$\frac{0}{0}$	$\frac{160 \pm 114}{2.0 \pm 1.4}$	$\frac{3171 \pm 791}{37.8 \pm 7.7}$	$\frac{4675 \pm 1586}{54.5 \pm 9.5}$	$\frac{115 \pm 100}{1.3 \pm 1.1}$

more in line with published values. The hematocrit is slightly lower, as one would expect; and the hemoglobin is roughly the same. Influence of sex, climate, and nutrition; breed differences; and the effect of parturition must be evaluated when comparing our data with that of the literature. White blood cells (WBC) are slightly higher in number than normally found in a dairy herd. There is a tendency for the herd to have more segmented neutrophils and less lymphocytes than normal. Because these values are consistent throughout the year and are a herd average, one must consider these values as normal for our dairy herd under the conditions they now are maintained.

The above discussion was not intended to go into any detail, but to cover the highlights of certain observations. Detailed reports on each phase are currently in progress.

IV. HERD PARTICIPATION IN USPHS EXPERIMENTS

A. INTRODUCTION

The USPHS Area 15 Experimental Farm and dairy herd are used in determining, in part, the total assessment of radioiodine uptake by dairy cows. Total assessment must include measurement of air uptake, uptake from ingestion of contaminated fresh green forage, uptake from ingestion of contaminated hay and/or grain, and uptake from contaminated water. The general outlines of field studies designed to investigate these different types of radioiodine uptake by dairy cows are presented as well as methods of animal husbandry necessary to mount field studies.

One of the objectives of the Farm Support Section is to develop facilities for maintaining dairy cows in the field under simulated farm conditions similar to those existing in the Great Basin states.

The responsibility for the dairy program was assumed just prior to the scheduled date of the TORY II-C reactor test, May 11, 1964. Because there was insufficient time to design a sophisticated restraint system, cows maintained in the predicted effluent pattern were tethered with nylon ropes and halters to posts set below the surface of the ground. Hay was fed on the ground, and the cows were watered in a modified cut-off 50-gallon drum. This system had obvious shortcomings; we could not determine the cows' orientation to the reactor at time of release nor could we determine the amount of feed consumed by each cow.

The next event that utilized cows in the field was Project SULKY, detonated on December 18, 1964. To eliminate some of the difficulties that were encountered during the TORY II-C study, we used individual stanchions were used for Project SULKY. A standard dairy stanchion was mounted on a 4-foot x 7-foot plywood platform over a channel steel box. Six of these individual platforms were connected to each other. Hay was fed in unattached wooden boxes. Grain and water were supplied to the cows in small plastic tubs at the time of milking. These stanchions were not sturdy enough for long usage in the field, and the feeding and watering system required too

many man hours to maintain the cows at peak milk production. For further details, see the report "Radioiodine Studies in Conjunction with Project SULKY," SWRHL-29r.

For the next event, Project PALANQUIN detonated on April 14, 1965, stanchions were modified by strengthening the head holders and bracing the metal attachments so the stanchions formed an individual portable unit. An automatic watering system was bolted to each stanchion and attached to a 500-gallon supply tank. Electric heaters were placed in the supply tank to prevent freezing of the water. Large plywood boxes were attached in front of each stanchion. The boxes had high backs and sides that prevented any of the hay or grain from being tossed about. The watering and feeding systems were designed to materially reduce the possibility of resuspension and cross contamination. This system greatly restricted the movements of the dairy animals. Many of the animals developed rear-leg lameness after being in the stanchions for several days. Also, the cows had no protection from the elements during the milking operation, which led to chapped teats and udders. Further, the electric pulsators on the milker froze and were inoperable during severe weather.

A new system correcting the deficiencies of previous ones was designed for future field experiments. In this new type pen, each cow is free to roam in a 9' x 9' x 5' steel pipe portable pen (Figure 12). A plastic feed box is entirely enclosed within a three-sided metal enclosure that has rubber webbing on the back thereby preventing the animal from pulling out hay and causing possible resuspension of radioactivity (Figures 13 and 14). The water system is automatic and metered. The first prototype had the main water supply elevated 10 feet above ground level so that gravity pressure was sufficient to supply an adequate amount of water for each cow. The system was modified by eliminating the elevated water tank and installing an in-line automatic constant pressure water pump at the outlet of the portable water tank.

A milking trailer has been developed as part of this pen complex. It contains one milking stanchion, a sink, and a hot water heater. Warm

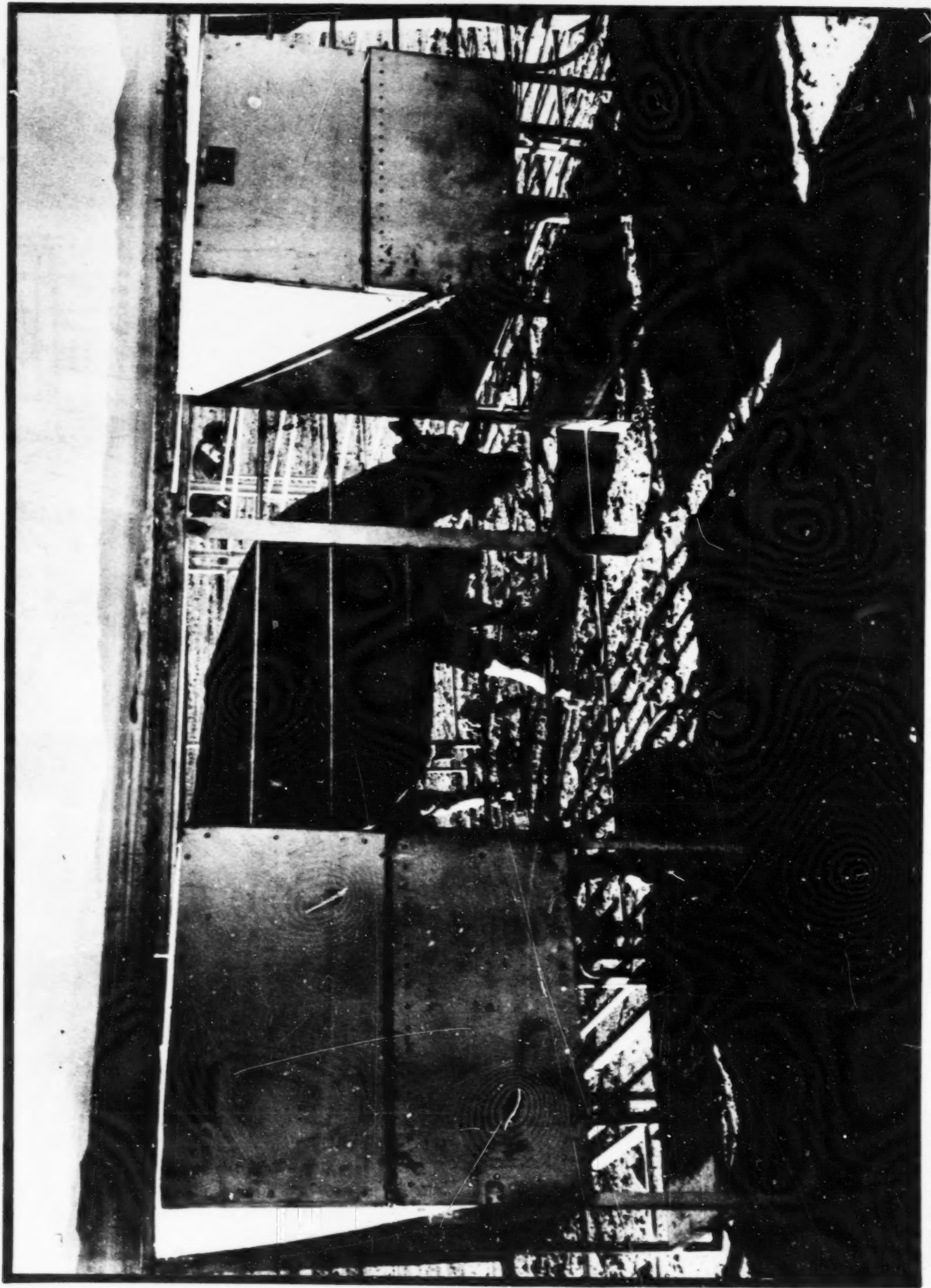


FIGURE 12 Front view of feed box holder attached to
9' x 9' x 5' steel pipe portable pen.

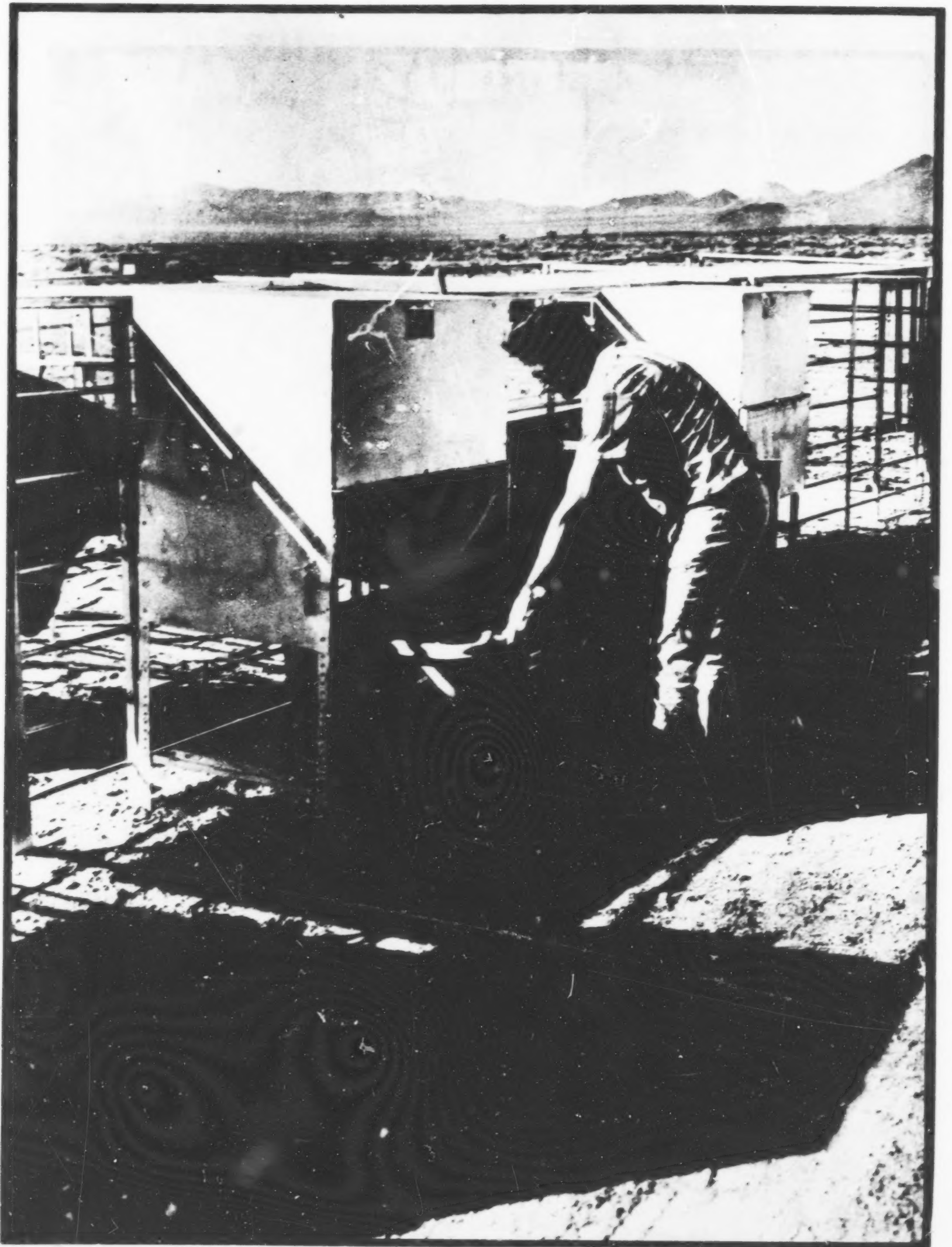


FIGURE 13 Plastic feed box being inserted
in a feed box attached to a portable pen.

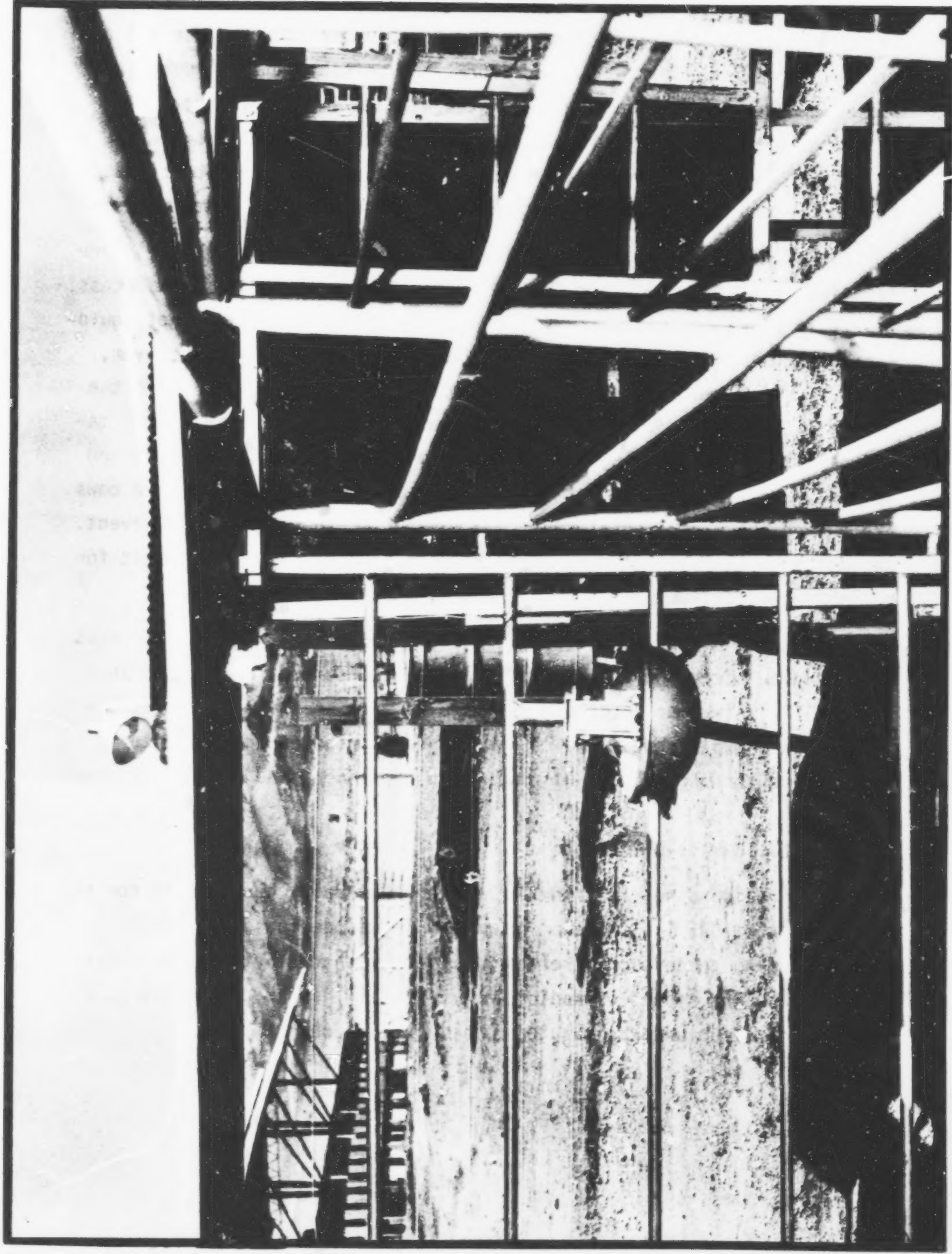


FIGURE 14 View of the back side of a feed box holder attached to the front of a portable pen and the automatic waterer.

running water is available to clean the cow's udder and to disinfect and clean the milking equipment. Therefore, the portable milking system is protected from the elements and operates with maximum efficiency. All equipment has been designed to operate at ambient temperatures down to -20°F . The gradual increase in sophistication of our equipment has been reflected by the development of improved experimental techniques.

For the most part, milking and sampling procedures used in the field are identical to those used on a routine basis at the dairy barn. By necessity, it is sometimes necessary to alter such things as the types of equipment used, time of milking, and method of preparing the cow. However, the basic fundamentals are always adhered to by the personnel doing the milking. Other than the vacuum system obtaining its power from a portable generator, the milking equipment is operated at the same vacuum and speeds. Individual equipment is used for each cow. As a rule, the cows are put on the experimental routine 3 days prior to the scheduled event. Depending on the particular experiment, the cows may be in the field for up to 2 weeks or longer.

A summary of the cows participating in each experiment in which the cows are arranged according to experiment and type of exposure is found in Appendix XI; likewise, Appendix XII is a summary of the cows participating in each experiment in which the cows are arranged according to cow numbers showing participation in each experiment and type of exposure.

B. PROJECT TORY II-C REACTOR

The first radioiodine study involving the USPHS dairy herd was in connection with the TORY II-C reactor project. It was deemed appropriate for this operation to develop a research project with the primary objective of measuring the amount of radioiodine which will enter cow's milk as a result of fallout under simulated summer feeding conditions.

Two of four objectives were:

- a. To relate environmental levels of radioiodine to resulting levels in cow's milk from inhalation plus ingestion from simulated summer-feed-lot conditions.
- b. To obtain an estimate of the amount of radioiodine which enters cow's milk as a result of ingestion alone.

1. TORY II-C--INTERMEDIATE RUN, May 11-17, 1964

Two stations were established on the 4,000-foot arc from TORY II-C test cell. These stations were located in such a fashion as to maximize the probability that either one or the other would obtain some fallout. Piles of green chop were distributed on plastic sheets that were arranged as a rectangle with the long axis perpendicular to the radial line from the test cell. If the green chop were contaminated with fallout, it would be removed after the run, transported to the Well 3 dairy barn and fed to four lactating Holstein cows.

2. TORY II-C--FULL POWER, May 20-25, 1964

Similar type stations were established on the 4,000-foot arc. Each station included a holding area for four dairy cows. A plastic sheet to hold green chop was in the immediate vicinity and oriented similarly to the green chop pile for the TORY II-C intermediate run. If either station were contaminated, the green chop would be fed to the cows at that station following the event (See Table 5).

For more details, refer to Memorandum Report on Radioiodine Studies Plan for Specified Reactor Runs dated 11 Apr 66, Part I.

Table 5. Groups of Cows for Project TORY II-C--Full Run, May 20, 1964.

GROUP	COW NO.	LOCATION	REMARKS
I	1	Station 10 4,000-foot Arc	For inhalation studies. Cows were tethered to sunken posts.
	9		
	10		
	12		
II	11	Station 16 4,000-foot Arc	For inhalation studies. Cows were tethered to sunken posts.
	13		
	15		
	17		
III	2	Dairy Barn Well 3	For ingestion study. Cows were fed measured amounts of contami- nated green chop.
	5		
	6		
	7		

C. RADIATION BIOLOGY LABORATORY EXPERIMENT, RB-1, AUGUST 10-17, 1964

The purpose of this experiment was to establish techniques for the collection of milk samples containing very low concentrations of ^{131}I . Decontamination procedures, proper labeling, and expeditious handling of samples were emphasized.

On August 10, 1964, 1.25×10^3 pCi of $\text{Na } ^{131}\text{I}$ were injected intravenously into Cows 13 and 15; Cows 7 and 9 served as controls. Sampling ended on August 17, 1964.

D. PROJECT KIWI REACTOR

KIWI--Full Power, August 28, 1964.

KIWI--Full Power, September 10, 1964.

This study was for the continuation of a research project with the primary objective of measuring the amount of radioiodine which will enter cow's milk as a result of fallout under simulated summer-feeding conditions. Green chop was placed in the predicted effluent trajectory.

There were three fixed stations on the 32,000-foot arc, two mobile stations about 10 to 15 miles from KIWI test pad, and one mobile station out approximately 20 to 30 miles. Following the reactor run, all the green chop was brought to the dairy barn, Well 3, NTS, and fed to lactating dairy cows (Table 6).

Table 6. Groups of Cows for Project KIWI.

GROUP	COW NO.	REMARKS	INTERVAL OF FEEDING
I	1, 8, 19, 21	Control	August 28-September 2, 1944
II	4, 7, 9, 17	Ingestion	August 28-September 2, 1944
I*	1, 4, 7, 8, 13, 16, 17, 18, 20, 21	Ingestion	September 10-12, 1964

*No control cows were used.

E. PROJECT SULKY, December 18, 1964

Project SULKY was a nuclear-cratering experiment in hard rock executed as part of the Plowshare Program for development of nuclear excavation. It was deemed appropriate to develop a research proposal having the primary objective of measuring the amount of radioiodine, as a result of fallout, which would be secreted in the milk of dairy cows fed under simulated winter-feeding conditions. Two specific objectives were established for the Farm Support Section.

1. To relate environmental levels of radioiodine to resulting levels in milk of dairy cows maintained under simulated winter-feeding conditions (Table 7).

2. To determine the amount of radioiodine deposited upon stacked-baled alfalfa hay and upon piled-loose alfalfa hay.

Table 7. Groups of Cows for Project SULKY, December 6-19, 1964*

GROUP	COW NUMBERS	STATION	TYPE OF EXPOSURE
I	1, 13 8, 27	F - 6 N - 6	Inhalation
II	11, 21, 23, 29 24, 25, 26, 28	F - 6 N - 6	Inhalation--ingestion
III	2, 16, 22	Camp 16	Ingestion

*Dates cows were on experiment.

Although concentrations of radionuclides released from this event were of such low activity that none of the primary objectives of the study were accomplished, much was learned from this exercise in regard to the care and milking of animals in the field. Shortcomings in our equipment and techniques became quite apparent. Modifications to overcome these shortcomings were made before the next field event and helped insure the successful accomplishment of its experimental objectives.

Full details of the SULKY Experiment may be found in the report "Radioiodine Studies in Conjunction with Project SULKY," SWRHL-29r.

F. PROJECT TNT, January 12, 1965

In conjunction with the transient nuclear test (TNT) of a KIWI reactor, hay contamination and controlled dairy-cow ingestion studies for radioiodine were conducted. The studies were designed to simulate the maximum possible radioiodine uptake by dairy cows from typical winter

dairy-farming practices where radioiodines enter the cow via ingestion of contaminated hay. Two of five objectives were, as follows:

1. To determine the amount of radioiodine deposited on stacked-baled alfalfa hay and on loosely piled alfalfa hay at the same locations.
2. To determine the kinetics of the uptake and secretion of radioiodines in milk of dairy cows following ingestion of contaminated hay (Table 8).

Table 8. Groups of Cows for TNT, January 13-18, 1965*

GROUP	COW NUMBERS	HAY STATION	REMARKS
I (Ingestion)	1, 11, 13, 21, 23, 29	8 - 215	Loose hay was located on 8,000-ft. arc at 215° azimuth
II (Ingestion)	8, 24, 25, 26, 27, 28	4 - 230	Loose hay was located on 4,000-ft. arc at 230° azimuth
III (Control)	2, 16, 22	Well 3	Loose noncontaminated hay located at Well 3

*Dates cows were on experiment.

Details of the experiment will be published in a report by the Bioenvironmental Research Program entitled "Radioiodine Studies Following the Transient Nuclear Test (TNT) of a KIWI Reactor," SWRHL-26r. An article authored by D. S. Barth, S. C. Black, and R. E. Engel and entitled "Radioiodine Studies Following the Transient Nuclear Test of a KIWI Reactor" was presented at the Health Physics Society Meeting, Houston, Texas, June 29-30, 1966.

G. PROJECT PALANQUIN, April 14, 1965

This event was a nuclear-cratering experiment of the Plowshare program. It was deemed appropriate for this operation to measure the radioiodine characteristics of released debris at distances close to the point of release. Data obtained would then be compared to similar data collected following the TNT reactor experiment.

Two major objectives were established for the Farm Support Section. The first was to determine the kinetics of the secretion of radioiodine in the milk of dairy cows fed contaminated hay or green chop in a controlled ingestion experiment, and the second was to determine the uptake of and resulting secretion of radioiodine in the milk of cows maintained in a contaminated environment but not allowed to eat contaminated food. A secondary objective was the determination of the kinetics of uptake and body distribution of radioiodine in calves drinking milk from cows involved in the ingestion experiment. Summary of treatment and grouping is listed in Table 9.

Three stations were set up on Pahute Mesa. Station 1, at 3 miles and 350° azimuth, had hay and green chop piles. Station 2, at 3 1/2 miles and 025° azimuth, also had hay and green chop. Station 3, at 4 miles and 005° azimuth, in addition to the feed piles, had four lactating and three nonlactating cows in stanchions for air uptake studies. Four of these cows were returned to the dairy after the event and entered the regular milking schedule. They were fed only uncontaminated hay. The three nonlactating cows were sacrificed singly at 62, 76, and 125 hours after exposure to determine tissue distribution of radionuclides. Of the unexposed cows at the dairy barn, six were fed contaminated green chop from Station 3, six were fed contaminated hay from Station 3, and three were fed contaminated hay from Stations 1 and 2.

Four calves were fed 8 lbs. of milk containing radioiodine at each milking. Two were given milk from Group I cows, and two were given milk from Group II cows. The calves were in vivo thyroid counted, sacrificed,

and the tissue distribution of radioiodine measured. Approximately 35 tissue samples and 11 GI tract content samples were taken from each of the sacrificed cows and calves.

Table 9. Groups of Cows for Project PALANQUIN, April 5-May 2, 1965*

GROUP	COW NO.	LOCATION	TYPE OF EXPOSURE	EXPOSURE DURATION
I	15, 18, 23, 26, 27, 29	Well 3	Sta. 3--Green chop**	Fed 20 lbs/day of contami- nated green chop from Sta. 3, Apr. 16-19, incl.
II	12, 19, 21, 22, 24, 25	Well 3	Sta. 3--Hay	Fed 15 lbs/day of contami- nated hay from Sta. 3, Apr. 16-23, 1965.
III	13, 16, 28	Well 3	Sta. 1--Hay and Sta. 2--Hay	Fed 15 lbs/day of contami- nated hay from Sta. 3, Apr. 16-24, from Sta. 1, Apr. 25-May 2, 1965.
IV	1, 2, 5, 11	Sta. 3, Area 20, Pahute Mesa	Air uptake at Sta. 3	During cloud passage and resuspension by wind Apr. 14-16, 1965.
V	4	Sta. 3, Area 20, Pahute Mesa	Air uptake at Sta. 3	During cloud passage and resuspension by wind Apr. 14-16. Cow 4 sacri- ficed April 16, 1965.
	7			Cow 7 sacrificed Apr. 17.
	9			Cow 9 sacrificed Apr. 19.
VI	30	Well 3	Milk from Gp. I and II	Fed milk Cow 15, Gp. I-- sacrificed May 25, 1965.
	31			Fed milk Cow 19, Gp. II-- sacrificed Apr. 16, 1965.

*Dates animals were on experiment.

**Procured from Pat McDonald Farm and Clark County Rehabilitation Farm,
Las Vegas, Nevada.

Table 9. Groups of Cows for Project PALANQUIN, April 5-May 2, 1965*
(Continued)

GROUP	COW NO.	LOCATION	TYPE OF EXPOSURE	EXPOSURE DURATION
VI	32	Well 3	Milk from Gp. I and II	Fed milk Cow 12, Gp. II--sacrificed Apr. 16, 1965.
	33			Fed milk Cow 26, Gp. I--sacrificed May 24, 1965.

*Dates animals were on experiment.

**Procured from Pat McDonald Farm and Clark County Rehabilitation Farm, Las Vegas, Nevada.

H. PROJECT MILKRUN, August 11, 1965

Any study of radioiodine dosimetry must necessarily include consideration of all possible radioactive iodines. Of the radioiodines of intermediate half-life, the ^{126}I isotope with a half-life of 13.2 days has been ignored in general, since this isotope is not a fission product. This study was conducted to test analytical techniques as well as to determine the effective half-lives of various mixtures of these two radioiodines. The principal objectives were:

1. To develop analytical techniques for detection of ^{126}I in the presence of ^{131}I .
2. To determine the variation with time of ^{126}I and ^{131}I levels in milk from cows given a single ingestion dose of these iodines mixed in various proportions.
3. To determine calf thyroid uptake from ingestion of milk obtained under objective 2.
4. To compare the results from AgI precipitation and from ion exchanged separation methods with gamma spectrometry results.

Eight mature, lactating Holstein cows were divided into four groups of two cows each. In the morning and evening, 3.6 liters of milk from one cow in each group was fed to its assigned calf. Summary of dose and cow assignments are listed in Table 10.

Table 10. Groups of Cows for Project MILKRUN, August 11-Sept. 2, 1965*

GROUP NO.	COW NO.	REMARKS
I	15, 27	Given oral dose via gelatin capsule of 95.6/ μ Ci ^{131}I and 24/ μ Ci ^{126}I
II	19, 21	Given oral dose via gelatin capsule of 106.2/ μ Ci ^{131}I and 16/ μ Ci ^{126}I
III	18, 25	Given oral dose via gelatin capsule of 106.2/ μ Ci ^{131}I and 8/ μ Ci of ^{126}I
IV	12, 28	Given oral dose via gelatin capsule of 116.8/ μ Ci of ^{131}I only
V**	35	Fed milk from Cow 27, 3.6 liters twice daily
	36	Fed milk from Cow 21, 3.6 liters twice daily
	40	Fed milk from Cow 25, 3.6 liters twice daily
	41	Fed milk from Cow 28, 3.6 liters twice daily

*Dates cows were on experiment.

**Calves used for milk-ingestion study.

Further details can be found in a report prepared by the USPHS/SWRHL Bioenvironmental Research Program entitled "Study of a Single Dose ^{131}I - ^{126}I Ratio in Dairy Cows," SWRHL-27r.

I. PROJECT HAYSEED, October 4, 1965

The major purpose of Project HAYSEED was to relate our artificial systems for obtaining contamination to a more realistic system when the contaminant is a synthetic, dry aerosol tagged with ^{131}I . The availability of a good stand of Sudan grass (*Sorghum sudanese*) at the USPHS Experimental Farm, Area 15, Nevada Test Site, gave us the capability of establishing relationships between the contamination characteristics of three systems:

1. Spread hay (as for PALANQUIN)
2. Spread green chop (as for PALANQUIN)
3. Growing Sudan grass

A dry aerosol (diatomaceous earth tagged with ^{131}I) was chosen because such a material may simulate close-in particulate fallout from a nuclear excavation experiment conducted in a desert environment.

The primary objectives:

1. To relate the amounts of ^{131}I deposited per kilogram upon spread hay, spread green chop, and growing Sudan grass as a result of dissemination of ^{131}I in the form of a dry aerosol.
2. To relate the kinetics of the secretion of ^{131}I in the milk of dairy cows fed the three different types of contaminated forage described above.
3. To determine the uptake of ^{131}I and subsequently to follow the kinetics of secretion of this ^{131}I in the milk of dairy cows maintained in a contaminated environment but not allowed to eat contaminated food or water.

Twenty lactating Holstein dairy cows were divided into five groups of four each. Six calves made up a group. These animals were grouped for this experiment as listed in Table 11.

Table 11. Groups of Cows for Project HAYSEED, October 4-22, 1965*

GROUP	COW NO.	TYPE OF FEED	REMARKS
I	1, 5, 46, 47	Uncontaminated hay and green chop	Inhalation--Area 15 facility, placed in position 4 A.M., Oct. 4, 1965; removed 7 A.M.
II	12, 19, 21, 25	Contaminated hay and uncontaminated green chop	Fed contaminated hay from P.M. Oct. 4, 1965 to A.M. Oct. 9, 1965.
III	15, 18, 27, 29	Contaminated spread green chop and un- contaminated hay	Fed contaminated green chop from P.M. Oct. 4, 1965 to A.M. Oct. 7, 1965.
IV	43, 44, 45, 48	Uncontaminated hay and contaminated growing green chop	Fed contaminated green chop from P.M. Oct. 4, 1965 to A.M. Oct. 9, 1965.
V	13, 24, 28	Uncontaminated hay and uncontaminated green chop	Control cows
VI**	42	8 lbs. milk A.M. and P.M.	Fed milk from Cow 21, Group II
	49	"	Fed milk from Cow 25, Group II
	55	"	Fed milk from Cow 27, Group III
	51	"	Fed milk from Cow 29, Group III
	53	"	Fed milk from Cow 48, Group IV
	54	"	Fed milk from Cow 43, Group IV

*Dates cows were on experiment.

**Calves used for milk-ingestion study.

Details of the project may be found in the SWRHL-28r report entitled "¹³¹I Dairy Cow Uptake Studies Using a Synthetic Dry Aerosol" and in a paper entitled "Radioiodines Transport Through the Ecosystem Air-Forage-Cow-Milk Using a Sythetic Dry Aerosol" by Delbert Barth and Morgan Seal. The latter was presented at the International Symposium on Radiological Processes which was held in Stockholm, Sweden, on April 28-29, 1966.

J. PROJECT ALFALFA, June 21, 1966

This project was essentially a repeat of Project HAYSEED. Improved aerosol generation techniques were employed to attempt to obtain a more homogenous deposition over the entire experimental array.

The primary objectives were:

1. To interrelate the amounts of ^{131}I deposited per kilogram upon spread alfalfa hay, spread alfalfa-oats green chop, and growing alfalfa and oats as a result of dissemination of the ^{131}I in the form of a dry aerosol.
2. To interrelate the kinetics of the secretion of ^{131}I in the milk of groups of dairy cows fed the three different types of contaminated forage described above.
3. To determine the air uptake of ^{131}I and subsequently to follow the kinetics of secretion of this ^{131}I in the milk of dairy cows maintained in a contaminated environment during cloud passage but not allowed to eat contaminated food or water.

Table 12. Groups of Cows for Project ALFALFA, June 21-July 6, 1966*

GROUP	COW NO.	TYPE OF FEED	REMARKS
I	21, 28, 43, 45	Uncontaminated hay (7.5 kg) and uncon- taminated and green chop (15 kg)	Inhalation group--placed in position 3:30 A.M., removed 5:30 A.M. June 21, 1966.
II	3, 26, 29, 47	Contaminated hay (15 kg)	Fed contaminated hay from A.M. June 21 to P.M. June 28, 1966.
III	2, 16, 44, 13	Contaminated spread green chop (15 kg)	Fed green chop from A.M. June 21 to P.M. June 23, 1966.
IV	12, 15, 17, 18	Contaminated grow- ing green chop (15 kg)	Fed green chop from A.M. June 21 to P.M. June 29, 1966.
V	19, 24	Uncontaminated hay (7.5 kg) and uncon- taminated green chop (15 kg)	Control group

* Dates cows were on experiment.

At this report date, the data are in the process of being compiled and summarized. A comprehensive report will be published in the future.

APPENDIX

Appendix I.	Farm Support Section Standard Operation Procedures for the USPHS/AEC Dairy Herd, FSS-SOP-1	58
Appendix II.	Individual Cow History as of July 1, 1966	68
Appendix III.	Nutritional Analysis of Alfalfa Hay	71
Appendix IV.	Lists of Ingredients in the Concentrates and Supplements	72
Appendix V.	Calf Records for USPHS Dairy Herd	74
Appendix VI.	Example of the American Breeder Service Forms Maintained for Each Cow in the USPHS Dairy Herd	82
Appendix VII.	Example of the DHIA Computer Sheet	83
Appendix VIII.	Standard Operating Procedures for Conduct of Dairy Cow Experiments (FSS-SOP-2)	84
Appendix IX.	Mastitis Incidence in Individual Cows	96
Appendix X.	Production Data for USPHS Dairy Herd	98
Appendix XI.	List of Cows Arranged According to Field Events and Type of Exposure	102
Appendix XII.	List of Cows Arranged by Cow Number Showing Participation in Experiments	104

APPENDIX I

FARM SUPPORT SECTION STANDARD OPERATION PROCEDURES FOR THE USPHS/AEC DAIRY HERD, FSS-SOP-1

While it is realized that dairy animals are not "machines" and therefore cannot be "run" by the number, a routine must be established and carried on by all animal handlers if our experiments are to have any validity. It is also realized that all possible contingencies cannot be covered in a document such as this, but certain basic dairy husbandry principles will be followed at all times.

The cows will be handled quietly and gently. No shouting, loud noises, sudden movements, or blows will be allowed. Cows should not be hurried and never struck or abused. They will be groomed frequently and efforts made to train them to halters and other methods of restraint. Those animals on test should be groomed and trained daily.

During milking and cleanup operations, rubber footwear will be worn for both sanitation and safety. The barn will be kept as clean as possible. Walls should be wiped with sponges or other suitable means to remove manure splatter every morning. The manger should be scrubbed with disinfectant solution daily. Feeding and milking will be done as regularly as conditions at the site permit. Under normal conditions milking will be at 0600 and 1600 hours. Only two machines will be utilized during milking with the third held in reserve for cows with mastitis. The machine to be used for mastitis will be clearly marked and used only for those cows that have mastitis.

The following method of milking will be used:

The De Laval System of Better Milking¹

Preparation of Cow

Udder and teats should be washed with a clean paper towel or cloth which has been immersed in water at 110° to 130°F. For best results the water

¹De Laval Pocket Diary, De Laval Separator Company, Milbrae, Calif., 1963

should contain a chlorine solution (200 to 250 p.p.m.) or a mild soap solution. This removes dust and dirt and also stimulates "let down" of milk, so essential in fast and clean milking. After the udder is washed, a clean paper towel will be used for drying the udder. Drying further stimulates "let down" of milk and removes excess water which might be drawn into the milker. Two or three streams of milk should be drawn from each quarter by hand into a strip cup. This procedure gives a final stimulus for milk "let down," opens teat meatus, and removes milk from teat and udder cisterns that is low in fat and higher in bacteria. Also, it affords an opportunity to determine the presence of abnormal milk. If the milk is flaky, stringy, bloody, or abnormal in any way, the animal should be milked last. If the condition indicates mastitis, she should be segregated to the end of the milking line and treated. To properly use the strip cup, the top which contains a fine wire mesh should be kept free of foam and sediment by occasional rinsing in clean water. It should be washed twice daily the same as any other dairy utensil. Never forestrip cows on the floor.

Caution

Teat cups should be in place within 1 minute after preparing the cow. If the cows are prepared too far in advance of milking, the muscles that cause the "let down" will tire. This will result in a lowered pressure in the udder and cause slow milking. They should be prepared just far enough in advance so that there will always be a cow ready. Careful timing will result in a smooth milking routine.

Applying the Teat Cups

After the cow has been prepared, hold the teat cup assembly with the tube connections up and the teat cups hanging down. This will kink them so that the teat cups will not draw in air. Turn on the milk valve and attach the teat cups. Hold the milk claw level with one hand and apply the cups with the other hand, kinking the stem at the neck while attaching to the teats.

Milking and Stripping

Although each cow should be milked as an individual, many users milk and strip their herd on an average of 3-4 minutes per cow. Some cows milk out considerably quicker than this, and a few may take somewhat longer. Occasionally, anatomical obstructions or defects prevent rapid milking. However, most cows milk out rapidly; and milking and stripping operations should not be prolonged, as this tends to cause the cows to become slow milkers and leaving the milker on after milk flow has ceased may irritate delicate udder tissues. Probably many "slow milking" cows are the result of slow-moving dairymen. Rapid milking saves time and promotes good udder health. The operator can easily examine the udder by touch and sight. When the udder is collapsed, soft, and pliable, it is an indication that the cow has finished milking. The operator should then feel the udder, gently massaging the quarters to determine if any residual milk is present. If residual milk (stripping) is present, place a little tension on the claw with one hand and stroke the quarters with the other hand in a downward motion toward the top of the teat cup. This act should be done in unison with the pulsations, and the operator will feel the milk when it enters the teat cup.

To remove the teat cups, take hold of them in one hand and close the milk cock with the other. The teat cups are then easily removed from the teats. With a little practice, this can be done without soiling the outside surfaces of the milker pail by droplets of milk from the teat cups.

Before the machine is placed on the next cow, the teat cups should be immersed in a pail of clean water to remove all milk from inside the liners and then immersed in a pail of sanitizing solution. If the teat cups were placed directly into the sanitizing solution, it would soon become dissipated due to the droplets of milk. Water and sanitizing solutions should be changed at about every 12 to 15 cows.

Udder Sanitation

As soon as the cow has been stripped, the teat ends should be immersed in an antiseptic solution which rinses off residual milk, acts as a disinfectant, and removes attraction for flies. A solution of 200 to 250 p.p.m. of Chlorine, 2% soluble pine oil solution made with lukewarm water, and iodophor solution (25 p.p.m. available iodine), or ordinary 70% isopropyl alcohol is suitable for this purpose. Use of solutions containing detergents and other irritants should be avoided. A dipper or ladle filled with antiseptic solution may be used, or the teat ends may be swabbed with cotton saturated with the solution. Remember good milking is your best defense against udder troubles.

1. Hang the surge pail low and level.
2. Pull the surcingle well forward.
3. When she's milked out--take it off.

Record Keeping

Milk will be weighed after each cow is milked; and weights will be recorded in the record book, as follows: day, month, year, and time (24-hour clock), number of cow, and weight of milk. Any abnormalities in milk or cow will be reported as will the treatments.

Cows with mastitis will be treated, as follows:

1. Milked only with the machine to be used for mastitis.
2. Infected quarters are completely milked out.
3. End of teat swabbed with alcohol.
4. Immediately insert nozzle of infusion tube into the teat. Squeeze the entire contents of tube into the teat gland and massage the teat and udder to distribute antibiotic thoroughly. Treatment will be every milking period and will be continued for four milking periods after cessation of symptoms of mastitis. Parenteral treatment will supplement cows who are off feed, exhibiting an elevated temperature, running a fever, or otherwise sick. The veterinarian will be consulted on these cows.
5. All infected quarters should be treated immediately after the

last milking prior to drying up. Treatment should be repeated 2 weeks later after the infected quarters are milked out. The solution is then left in the quarters until they freshen. Consult veterinarian as to amounts and type of infusion to be used.

The California Mastitis Test (CMT) will be used the a.m. of every Monday. The CMT is designed to be made at the cow's side. The white plastic paddle with four shallow cups, marked A, B, C, and D, is designed to keep quarter samples separate.

The recommended amount of milk to use in each cup is 2 ml or the amount that will remain in the cup when it is turned to a near vertical position. To this add an equal amount of CMT reagent. Too little or too much reagent gives false results. Gently rotate the paddle in a circular pattern so that milk and reagent are mixed thoroughly. This requires about 10 seconds. Continue the rotation as the mixture is "graded."

Grading will be done in accordance to chart on page 10 of "Milking Management" pamphlet. Animals showing reactions of 2 (distinct positive) and above will be treated in accordance with preceding instructions.

Scrubbing Milking Equipment

Immediately after last cow is milked:

1. Snap the surge units apart and place inflations, lid, and lid gasket into clean, cold water. Don't leave inflations in shells! Thoroughly rinse surge pails with clean, cold water. Milk dries rapidly, and dried milkstone causes more work.
2. As soon as possible scrub all metal parts and scrub all rubber parts in water not over 140 degrees, to which a mild detergent has been added. NEVER USE SOAP.
3. Rinse all parts with clean hot water.
4. Sanitize with manufacturer's recommended strength of disinfectant.
5. Hang equipment on hangers. Do Not Leave in Tank.
6. Rinse all parts in disinfectant solution just before next milking.

Care of Milking Equipment

Surge recommends the vacuum to be carried at 13-14 inches. This should be checked before each milking.

Surge recommends the pulsator speed at around 55 strokes per minute for average cows. Sensitive cows can be milked at 65 and hard slow milkers at 45.

The vacuum hose will be scrubbed with the brush at least every 2 weeks.

Leathers of pulsator will be kept oiled to keep them soft. Just one drop of pulsator oil on each of the four leathers once a week is enough. Excess oil is drawn through into the space between the shell and the inflation and is bad for the rubber.

Vacuum pump will be serviced according to the manufacturer's instructions.

Records of maintenance will be kept in a book so that they are not duplicated by another operator--record date, procedure, and finding.

Specific rations for the cows will be worked out by the dairy supervisor and the Chief, Farm Support Section. A rule of thumb for feeding follows: feed the dairy cow all the good roughage she will take, and then balance ration with grain. This should approximate 2 to 2 1/2 pounds of hay daily for each 100 pounds live weight (approximately 30-35 pounds). Holsteins require 1 pound of grain for every 4-5 pounds of milk produced.

These are only rules of thumb, and Morrison's Table (Table I-A) gives more exact grain mixture amounts to be fed on basis of production. Cows will be fed individually according to their yield of milk. Cows will have free access to salt and water.

Cows should have a dry period of from 30 to 60 days before calving. The best method to dry up a cow that is not giving more than 20 pounds of milk a day is to discontinue milking. If a cow is giving more milk than this, her production can be reduced to 20 pounds by restricting her feed. If the udder fills so much with milk that there is danger of its becoming congested, the cow should be milked out and only milked again as may be necessary. The Chief, Farm Support Section, should be notified if a cow

having mastitis is to be dried up so that special treatment may be given. If a cow is in fairly good condition when she is dried off, 2-4 pounds of grain mixture a day with good roughage will be sufficient.

After calving, a cow should be watched to see if she "cleans" properly and does not develop any complications, such as udder edema, mastitis, etc. Placenta will be removed from the cow's area as soon as it is dropped to prevent ingestion of the tissue by the cow. Do not allow cow to eat the placenta. Calves will be permitted to nurse for the first 3 days and then weaned. The cow will not be bred back until 60 days after calving.

After a calf nurses for 3 days (necessary to get colostrum), it may be put on whole milk which should not exceed 1 pint (1 pound) for each 10 pounds of the calf's weight. Weak or sickly calves should be fed less, and even a large and vigorous calf should not be fed more than 11 pounds a day. In case of indigestion or scours, the allowance should be cut in half until the calf recovers. It is important that pails and other calf-feeding equipment be kept scrupulously clean at all times to avoid digestive disturbances.

In case of scours, the veterinarian is to be notified and his treatment regime followed.

Try to teach the calf to eat calf starter as soon as possible after the first 3 days of colostrum feeding. It can be self-fed with the proper amount of whole milk. A calf 2 weeks old will eat only a small handful of calf starter. It will eat 1/2 pound daily at 4 weeks, 1 pound at 6 weeks, 1 1/2 pounds at 8 weeks, and 2 pounds at 10 weeks to 3 months of age. This should be an adequate ration if milk is fed with a good quality hay. After the 14th day, the calf should be offered all it can eat of good quality hay, self-fed.

A safe age at which whole milk may be replaced entirely by calf starter, grain mixtures, and roughage will depend on the calf and its vigor.

Usually 6 weeks can be considered a safe age for this change, though healthy, vigorous calves may be changed as much as 2 weeks earlier with good results. Weaning will be between 5 and 7 weeks.

The yards and area around the trailers will be kept clean of trash and wire. Fencing materials and scrap lumber will be kept neatly piled. Drugs and equipment will be kept in their proper places and not be left lying around.

In addition to his routine work duties, the supervisor will be responsible for seeing that proper records are kept, that these operating procedures are adhered to, and that the Chief, Farm Support Section, is kept informed of all developments in writing. He will also maintain running inventories on feed, drugs, and other equipment so that replacements may be ordered, as necessary.

Table I-A. Grain Feeding Table for Cows Not on Pasture*

Hay equivalent consumed per 100 lbs. of live weight daily			Total Pounds of Grain Mixture or Concentrates to Feed	
2 1/2 lbs. Very liberal feeding of good roughage	2 lbs. Usual rate of feed- ing good hay or good hay and silage	1 1/2 lbs. Feeding scanty amount of good roughage or feeding poor roughage		
Milk Produced Daily, Pounds			Percentage of Fat in Milk	
Lbs.	Lbs.	Lbs.	3.0% 3.5% 4.0%	
17	10	..		
19	12	..		1.6
21	14	..	1.5	2.4
23	16	9	2.3	3.3
25	18	11	3.0	4.2
27	20	13	3.7	5.0
29	22	15	4.5	5.9
31	24	17	5.2	6.8
33	26	19	6.0	7.6
35	28	21	6.7	8.5
37	30	23	7.4	9.3
39	32	25	8.2	10.2
41	34	27	8.9	11.1
43	36	29	9.6	11.9
45	38	31	10.4	12.8
47	40	33	11.1	13.7
49	42	35	11.8	14.5
51	44	37	12.5	15.4

*Table above excerpt from 22nd edition, "Feeds and Feeding" by Frank B. Morrison.

Table I-A. Grain Feeding Table for Cows Not on Pasture* (Continued)

Hay equivalent consumed per 100 lbs. of live weight daily			Total Pounds of Grain Mixture or Concentrates to Feed		
2 1/2 lbs. Very liberal feeding of good roughage	2 lbs. Usual rate of feeding good hay or good hay and silage	1 1/2 lbs. Feeding scanty amount of good roughage or feeding poor roughage			
Milk Produced Daily, Pounds			Percentage of Fat in Milk		
Lbs.	Lbs.	Lbs.	3.0%	3.5%	4.0%
53	46	39	13.3	14.8	16.3
55	48	41	14.1	15.6	17.1
57	50	43	14.8	16.4	18.0
59	52	45	15.5	17.2	18.9
61	54	47	16.3	18.0	19.7
63	56	49	17.0	18.8	20.6
65	58	51	17.7	19.6	21.4
67	60	53	18.5	20.4	22.3
69	62	55	19.2	21.2	23.2
71	64	57	19.9	22.0	24.0
73	66	59	20.7	22.8	24.9
75	68	61	21.4	23.6	25.8

*Table above excerpt from 22nd edition, "Feeds and Feeding" by Frank B. Morrison.

APPENDIX II

INDIVIDUAL COW HISTORY AS OF JULY 1, 1966

COW	AGE	WEIGHT IN LBS.	DATE OF ACQUI- SITION	COST OF ACQUI- SITION	SOURCE	TYPE	DISPOSITION	DATE OF DISPOSITION
1	7 yr. 8 mo.*	1370	Spring 1964	\$225.00	Dispersal sale-- Idaho	Grade	Died-- Traumatic Pericarditis	11 Jun 66
2	7 yr. 8 mo.*	1295	"	"	"	"	In herd	
3			"	"	"	"	Culled from herd to U of N	8 Oct 64
4			"	"	"	"	Sacrificed	15 May 65
5	7 yr. 3 mo.*	1300	"	"	"	"	In herd	
6			"	"	"	"	Culled from herd to U of N	8 Oct 64
7			"	"	"	"	Sacrificed	17 May 65
8			"	"	"	"	Died-- Typanites	15 Feb 65
9			"	"	"	"	Sacrificed	19 May 65
10			"	"	"	"	Culled from herd of U of N	8 Oct 64
11	6 yr. 3 mo.*	1340	"	"	"	"	In herd	
12	6 yr. 3 mo.*	1570	"	"	"	"	In herd	
13	5 yr. 9 mo.*	1435	"	"	"	"	In herd	

*Estimated

APPENDIX II (Continued)

COW	AGE	WEIGHT IN LBS.	DATE OF ACQUI- SITION	COST OF ACQUI- SITION	SOURCE	TYPE	DISPOSITION	DATE OF DISPOSITION
14			Spring 1964	\$225.00	Dispersal sale-- Idaho	Grade	Died-- Esophageal Obstruction	16 Feb 65
15	9 yr. 4 mo.	1560	"	"	"	"	In herd	
16	7 yr. 8 mo.	1825	"	"	"	"	In herd	
17	6 yr. 3 mo.	1335	"	"	"	"	In herd	
18	7 yr. 7 mo.	1440	16 Aug 64	"	U of Nev.	"	In herd	
19	10 yr. 2 mo.	1380	"	"	"	"	In herd	
20			"	"	"	"	Died-- Typanites	10 Apr 65
21	4 yr. 3 mo.	1290	"	"	"	"	In herd	
22			7 Nov 64	No charge	"	"	Nurse Cow	5 Aug 65
23			"	"	"	"	Nurse Cow	5 Aug 65
24	6 yr. 7 mo.	1350	15 Nov 64	\$400.00	Cantlon Farms, Reno, Nev.	Regis.	In herd	
25	7 yr. 10 mo.	1520	"	"	Oats Bros. Fallon, Nev.	"	In herd	
26	6 yr. 4 mo.	1870	"	"	Oats Bros. Fallon, Nev.	"	In herd	
27	4 yr. 7 mo.	1520	"	"	Cantlon Farms, Reno, Nev.	"	In herd	
28	7 yr. 10 mo.	1555	"	500.00	Oats Bros. Fallon, Nev.	"	In herd	

APPENDIX II (Continued)

COW	AGE	WEIGHT IN LBS.	DATE OF ACQUI- SITION	COST OF ACQUI- SITION	SOURCE	TYPE	DISPOSITION	DATE OF DISPOSITION
29	6 yr. 8 mo.	1525	15 Nov 64	\$430.00	Cantlon Farms, Reno, Nev.	Regis.	In herd	
43	3 yr. 8 mo.	1490	23 Jul 65	450.00	"	"	In herd	
44	6 yr. 10 mo.	1700	"	"	"	"	In herd	
45	6 yr. 2 mo.	1490	"	500.00	Oats Bros. Falcon, Nev.	"	In herd	
46	5 yr. 9 mo.	1380	"	"	"	"	In herd	
47	8 yr. 2 mo.	1690	"	400.00	"	"	In herd	
48	4 yr. 3 mo.	1483	"	450.00	"	"	In herd	

APPENDIX III

NUTRITIONAL ANALYSIS OF ALFALFA HAY*

DATE	MOISTURE	FIBER	ASH	PROTEIN	DIGESTIBLE PROTEIN	FAT	TDN	CAROTENE	CAL- CIUM	PHOS- PHORUS
28 Jun 65	NA	25.59%	NA	16.74%	NA	NA	NA	77.0 PPM 35.0 mg/lb 58,345 IU/lb	NA	NA
20 Aug 65	10.32%	24.76%	8.27%	16.83%	NA	1.88%	51.4%	77.0 PPM 35.0 mg/lb 58,345 IU/lb	2.6%	0.1%
3 Nov 65	8.54%	22.71%	6.73%	16.80%	15.8%	2.46%	54.6%	122.0 PPM 55.0 mg/lb 91,685 IU/lb	NA	NA
14 Jan 66	10.50%	23.21%	6.86%	16.66%	14.93%	1.82%	52.72%	71.5 PPM 32.5 mg/lb 54,177.5 IU/lb	NA	NA
25 May 66	7.64%	25.90%	8.53%	15.15%	14.3%	1.22%	52.6%	66.0 PPM 30.0 mg/lb 50,010 IU/lb	3.8%	0.12%
25 Jun 66**	8.56%	27.40%	8.04%	17.39%	13.43%	1.33%	51.2%	83.0 PPM 40.0 mg/lb 66,680 IU/lb	0.94%	0.16%
Average	9.13%	24.92%	7.69%	16.60%	14.62%	1.74%	52.5%	83.6 PPM	2.4%	0.13%
Standard	±0.55	±0.72	±0.37	±0.31	±0.50	±0.22	±0.61	±8.24	±0.8	±0.02
Error of								37.9 mg/lb		
the Mean								±3.68		
								63,207 IU/lb		
								±6,127		

*Performed by Morse Laboratories, 316 16th St., Sacramento, California.

**First Crop, 1966, USPHS Experimental Farm

NA = Not Analyzed.

APPENDIX IV

LIST OF INGREDIENTS IN THE CONCENTRATES AND SUPPLEMENTS

FEED	INGREDIENTS	GUARANTEED ANALYSIS	
16% Dairy*	Ground barley and/or ground oats, ground yellow corn and/or ground grain sorghums, soybean meal and/or cottonseed meal, corn gluten feed and/or grain sorghums gluten feed, alfalfa meal, cane molasses and/or beet molasses and/or corn sugar molasses, oat mill by-product, ground mixed screenings, soybean mill feed, wheat middlings, urea, 2% calcium carbonate, 1% iodized salt, and traces of iron oxide, manganese sulphate, manganous oxide, copper oxide, cobalt carbonate, zinc oxide.	Protein	16.0
		Urea Protein	4.0
		Fat	2.5
		Fiber	15.0
16% Dairy**	Rolled Barley, Dried Beet Pulp, Cane Molasses, Beet Molasses, Wheat Mill Run, Cottonseed Meal, Linseed Meal, Ground Yellow Corn, Dehulled Soybean Meal, Vitamin A Palmitate, D-Activated Plant Sterol, Urea, Calcium Carbonate, Deflourinated Phosphate, Mineralized Salt (containing Iron Oxide, Manganese Sulfate, Sodium Thiosulfate, Copper Carbonate, Cobalt Carbonate, Potassium Iodide).	Crude Protein (Min.) (This includes not more than 5.25% equivalent crude protein from non-protein nitrogen)	16.00%
		Crude Fat (Min.)	2.00%
		Crude Fiber (Max.)	9.00%
		Ash (Max.)	9.50%

*Purina Chow 16% Dairy Chow

**Pillsbury's Best 16% Dairy Feed, The Pillsbury Company

APPENDIX IV (Continued)

LIST OF INGREDIENTS IN THE CONCENTRATES AND SUPPLEMENTS

FEED	INGREDIENTS	GUARANTEED ANALYSIS
Mineral Supple- ment***	Monosodium Phosphate, Deflourinat- ed, Sodium Tripolyphosphate, Salt, Cane Molasses, Wheat Bran, Wheat Shorts, Wheat Germ, Wheat Flour, Animal Fat (preserved with Buty- lated Hydroxytoluene), Lignin Sulfonate, Vitamin A Palmitate (stability improved), D-Activated Animal Sterol (source of Vitamin D-3), Cobalt Sulfate, Manganese Sul- fate, Potassium Iodide (with im- proved stability), Iron (ferrous) Sulfate, Magnesium Oxide, Copper Carbonate, Zinc Sulfate.	Calcium (Max.) 10.00% Calcium (Min.) 8.50% Phosphorus (Min.) 15.00% Iodine (Min.) 0.007% Salt (Max.) 10.00% Salt (Min.) 8.00% Moisture 12.00% Fluorine (Max.) 0.07% Cobalt (Min.) 0.005% Vita. A (Min.)-- 100,000 USPU/Lb

***ANI-MIN-REL, Montana Flour Mills Company

APPENDIX V

CALF RECORDS FOR USPHS DAIRY HERD

ID NUMBER	DATE OF BIRTH		DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
	WT.	SEX AT BIRTH					
581	23 May 1964	Female Unknown	4 and Unknown	Angus- Holstein	None	Replacement cow--beef herd	Had first calf Spring 1966.
AIU 2 ¹	23 May 1964	Male Unknown	4 and Unknown	Angus- Holstein	None	Sent to U of N 8 Oct. 1964	Part of shipment to reduce size of beef herd.
AIU 12	23 May 1964	Male Unknown	16 and Unknown	Angus- Holstein	None	Sent to U of N 8 Oct. 1964	Part of shipment to reduce size of beef herd.
582	5 July 1964	Female Unknown	8 and Unknown	Angus- Holstein	None	Replacement cow--beef herd	Had first calf Spring 1966.
AIU 26	14 July 1964	Female Unknown	17 and Unknown	Angus- Holstein	None	Sent to U of N 8 Oct. 1964	Part of shipment to reduce size of beef herd.
No number assigned.	17 July 1964	Female Unknown	14 and Unknown	Angus- Holstein	None	Died 19 July 1964	Heat prostration, not autopsied.
AIU 14	20 July 1964	Female Unknown	1 and Unknown	Angus- Holstein	None	Sent to U of N 8 Oct. 1964	Part of shipment to reduce size of beef herd.

¹Twins

APPENDIX V (Continued)

ID NUMBER	DATE OF BIRTH		DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
	WT.	AT BIRTH					
AIU 30	26 July 1964	Male Unknown	13 and Unknown	Angus- Holstein	None	Sent to U of N 8 Oct. 1964	Part of shipment, to reduce size of beef herd.
37	9 Oct. 1964	Male Unknown	11 and Unknown	Angus- Holstein	Surgical Techniques	Sacrificed 2 July 1965	Nonsurvival surgery, no samples taken.
38	25 Nov. 1964	Male Unknown	2 and Unknown	Angus- Holstein	Surgical Techniques	Sacrificed 2 July 1965	Nonsurvival surgery, no samples taken.
36	30 Dec. 1964	Female 60 lbs.	20 and Unknown	Holstein	MILKRUN 11-27 Aug. 1965	Retained as replacement heifer	Fed milk, Cow 21-- Group II. Thyroid counted in vivo. Transferred to Area 18--14 Apr 66.
31	4 Jan. 1965	Male Unknown	5 and Unknown	Hereford- Holstein	PALANQUIN 6-26 Apr 65	Sacrificed-- PALANQUIN 26 Apr. 1965	Weighed 245 lbs. at death. Fed milk, Cow 19--Group II. Thyroid counted in vivo and in vitro.
34	8 Jan. 1965	Male 100 lbs.	15 and Unknown	Hereford- Holstein	None	Replacement for beef herd	1 Jul 65 to beef herd, Area 18.
32	10 Jan. 1965	Male 75 lbs.	19 and Unknown	Holstein	PALANQUIN 6-26 Apr 65	Sacrificed-- PALANQUIN 26 April 1965	Wt. 325 lbs. at death. Fed milk, Cow 12--Group II. Thyroid counted in vivo and in vitro.

APPENDIX V (Continued)

ID NUMBER	DATE OF BIRTH		DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
	WT.	SEX AT BIRTH					
35	15 Feb. 1965 Female 60 lbs.		18 and Unknown	Holstein	MILKRUN 11-27 Aug. 1965	Retained as replacement heifer	Fed milk, Cow 27-- Group I. In vivo thyroid counting. Transferred to Area 18--14 Apr 66.
30	19 Feb. 1965 Female Unknown		12 and Unknown	Hereford- Holstein	PALANQUIN 6-26 Apr 65	Sacrificed 25 May 1965	Wt. 250 lbs. at death. Fed milk, Cow 15--Group I.
39	13 April 1965 Female 85 lbs.		28 and Oats Bull	Reg. Holstein	None	Retained as Dairy Cow replacement	Transferred to Area 18--14 Apr 66.
40	29 May 1965 Male 80 lbs.		21 and Unknown	Hereford- Holstein	Rumen cannula for gas collection. MILKRUN 11-27 Aug 65	Transferred to beef herd	Cannula was lost. Wound closed by natural healing. Fed milk, Cow 25-- Grp. III. Thyroid counted in vivo. Transferred to Area 18--26 Feb 66.
41	14 June 1965 Female 65 lbs.		13 and Hereford Bull	Hereford- Holstein	MILKRUN 11-27 Aug. 1965	Transferred to beef herd	Fed milk, Cow 28-- Group IV. Thyroid counted in vivo. Transferred to Area 18--14 Apr 66.

APPENDIX V (Continued)

ID NUMBER	DATE OF BIRTH SEX WT. AT BIRTH	DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
42	18 July 1965 Male 65 lbs.	25 and Oats Farm Katherine Invincible	Reg. Holstein	HAYSEED 4-22 Oct 65	Transferred to beef herd	428 lbs. on 12 Nov. 1965. Fed milk, Cow 21--Grp. II. In vivo thyroid count- ing. Transferred to Area 18--14 Apr 66.
49 ²	4 Aug. 1965 Female 50 lbs.	27 and Hereford Bull	Hereford- Holstein	HAYSEED 4-22 Oct 65	Transferred to beef herd	Fed milk, Cow 25-- Grp II. In vivo thyroid counting. Transferred to Area 18--14 Apr 66.
50 ²	4 Aug. 1965 Male 50 lbs.	27 and Hereford Bull	Hereford- Holstein	None	Transferred to beef herd	Vit. A deficiency as calf. Good recovery. Transferred to Area 18--14 Apr. 66.
51 ³	24 Aug. 1965 Female 50 lbs.	1 and Hereford Bull	Hereford- Holstein	HAYSEED 4-22 Oct 65	Transferred to beef herd	Fed milk, Cow 29-- Grp III. In vivo thyroid counting. Transferred to Area 18--14 Apr 66.
52 ³	24 Aug. 1965 Female 50 lbs.	1 and Hereford Bull	Hereford- Holstein	None	Died 21 Sept. 1965	Enterotoxemia-- Autopsied and Lab diagnosis.

2Twins

3Twins

APPENDIX V (Continued)

ID NUMBER	DATE OF BIRTH		DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
	WT.	SEX					
53	1 Sept. 1965 Female 50 lbs.		24 and Hereford Bull	Hereford- Holstein	HAYSEED 4-22 Oct. 65	Transferred to beef herd	215 lbs. 12 Nov 65. Fed milk, Cow 48-- Grp IV. In vivo thyroid counting. Transferred to Area 18--14 Apr 66.
54	30 Aug. 1965 Male 55 lbs.		29 and Hereford Bull	Hereford- Holstein	HAYSEED 4-22 Oct. 65	Transferred to beef herd	230 lbs. 12 Nov 65. Fed milk, Cow 43-- Grp IV. In vivo thyroid counting. Transferred to Area 18--14 Apr 66.
55	8 Sept. 1965 Female 55 lbs.		48 and Oats Sire	Reg. Holstein	HAYSEED 4-22 Oct. 65	Retained for dairy herd	210 lbs. 12 Nov 65. Fed milk, Cow 27-- Group III. In vivo thyroid counting. Transferred to Area 18--14 Apr 66.
56	10 Nov. 1965 Male 50 lbs.		17 and AI H-195	Grade Holstein	None	Died 12 Nov. 1965	Enterotoxemia No autopsy performed.
57	27 Nov. 1965 Male 60 lbs.		2 and AI H-195	Grade Holstein	None	Transferred to beef herd	Transferred to Area 18--9 Jun 66.

APPENDIX V (Continued)

ID NUMBER	DATE OF BIRTH		DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
	WT.	SEX AT BIRTH					
58	25 Jan. 1966 Female 81 lbs.		18 and 508	Hereford- Holstein	None	Beef herd Replacement	
59	31 Jan. 1966 Male 80 lbs.		5 and 508	Hereford- Holstein	None	Beef herd Replacement	
60	11 Feb. 1966 Male 68 lbs.		16 and 508	Hereford- Holstein	None	Beef herd Replacement	Transferred to Area 18--2 May 66.
61	13 Feb. 1966 Male 91 lbs.		45 and Oats Bros AI	Reg. Holstein	None	Beef herd Replacement	
62	16 Feb. 1966 Female 76 lbs.		43 and U of N Wisburke Abe AI	Reg. Holstein	None	Dairy herd Replacement	
63	16 Feb. 1966 Male 72 lbs.		22 and 508	Hereford- Holstein	None	Beef herd Replacement	Transferred to Area 18--2 May 66.
64	16 Feb. 1966 Male 78 lbs.		23 and 508	Hereford- Holstein	None	Beef herd Replacement	Transferred to Area 18--2 May 66.
65	24 Feb. 1966 Male 85 lbs.		26 and 508	Hereford- Holstein	None	Beef herd Replacement	Tranferred to Area 18--2 May 66.

APPENDIX V (Continued)

ID NUMBER	DATE OF BIRTH		DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
	WT.	SEX AT BIRTH					
67	24 Feb. 1966	Female	12 and 508	Hereford-Holstein	None	Beef herd Replacement	
68 ⁴	8 March 1966	Male	28 and 508	Hereford-Holstein	None	Beef herd Replacement	Transferred to Area 18--2 May 66.
69 ⁴	8 March 1966	Male	28 and 508	Hereford-Holstein	None	Beef herd Replacement	Transferred to Area 18--2 May 66.
70	2 April 1966	Male	47 and Oats Sire	Reg. Holstein	None	Dairy Herd Sire	
71	3 April 1966	Female	44 and Phantom (Cantlon)	Reg. Holstein	None	Dairy Herd Replacement	
72	12 April 1966	Male	15 and 508	Hereford-Holstein	None	Beef herd Replacement	Transferred to Area 18--2 May 66.
73 ⁵	31 May 1966	Female	13 and 509	Hereford-Holstein	None		
74 ⁵	31 May 1966	Male	13 and 509	Hereford-Holstein	None		

⁴Twins

⁵Twins

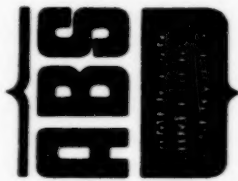
APPENDIX V (Continued)

ID NUMBER	DATE OF BIRTH		DAM AND SIRE	TYPE OF BREEDING	EXPERIMENTS PARTICIPATED	DISPOSITION	REMARKS
	WT.	SEX AT BIRTH					
75	13 June 1966 Female 70 lbs.		19 and 509	Hereford- Holstein	None		
76	13 June 1966 Male 75 lbs.		21 and 509	Hereford- Holstein	None		
77	25 June 1966 Male		46 and 509	Hereford- Holstein		Dead at birth	Uterine inertia caused asphyxiation as Dam had milk fever.

APPENDIX VI

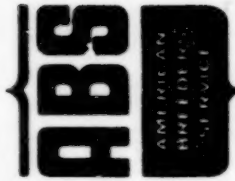
EXAMPLE OF THE AMERICAN BREEDER SERVICE FORMS MAINTAINED FOR EACH COW IN
THE USPHS DAIRY HERD

See Reverse for File Signal Code



HOLSTEIN

ABS INDIVIDUAL COW RECORD



REPRODUCTION

Date	Event	Date	Event	Date	Event	Date	Event
23 May 64	Freshened	2 Sep 65	Bred-Bull	8 Jun 66	Heat	5 Jan 67	Preg test-Pos
		12 Oct 65	Heat	14 Sep 66	Preg test open	12 Feb 67	Dry
		10 Jan 65	Heat	15 Dec 66	Preg test preg	20 Mar 67	Preg test-Pos
		10 Feb 65	Bred-A. I.			25 Apr 67	Freshened
		10 May 65	Bred-Bull No. 508			25 Apr 67	Milk fever
		29 Jul 65	Preg test-Pos			15 Jul 67	Bred Bull No. 70
		5 Aug 65	Dry				
		3 Sep 65	Preg test-Pos				
		11 Feb 66	Freshened				
		Due to Calve	17 Feb 66	Due to Calve		Due to Calve	
		Date Calved: 11 Feb 66	Sex M	Date Calved:	Sex	Date Calved: 25 Apr 67	Sex F
		Calf No. 60		Calf No.		Calf No. 100	Sire 508
		Name Angus-Holstein Cross		Name Herford-Holstein		Name	Cross
		Date Calved: 23 May 64	Sex M	Date Calved:	Sex	Date Calved:	Sex
		Calf No. AIU No. 12		Calf No.		Calf No.	
		Name Angus-Holstein Cross		Name		Name	

HEALTH RECORD

17 Feb 66- Tranvet	20 Oct 66-ADE vitamins	I.V.-partnuriert pare-
feet trimmed	(C.M.S.) I.M. Jan 67-	sis. 7 Jun 67-Bloat
27 Jul 66- Cryogenic	treated udder ointment	treatment. 1 oz. Slick
brand	Hexalube (Norden) 12 Apr	(Starbar) 13 Jul 67-
20 Aug 66 - 1cc Estrovar	67-50cc Cal-Gly-Phso	1 1/2 cc ADE vitamins I.M.
ian Anesteus	(Burns) Sub.Q. 26 Apr 67-	(Cal. Med.)
14 Sept 66- 2cc Estro-	500cc C.B.G. (Jen-Sal)	
varian I.M.		

APPENDIX VII

EXAMPLE OF THE DHIA COMPUTER SHEET

APPENDIX VIII

STANDARD OPERATING PROCEDURES FOR CONDUCT OF DAIRY COW EXPERIMENTS (FSS-SOP-2)

OBJECTIVE

Most Bioenvironmental Research experiments conducted with USPHS/AEC dairy cows will utilize quantities of radionuclides that will result in very low concentrations in the milk. In order to collect and process biological samples efficiently and with a minimum of errors, it is necessary to establish standard operating procedures (SOP) for the: (1) animal husbandry, (2) milking process, (3) sampling techniques, (4) record keeping, and (5) equipment decontamination. This SOP will be followed by the livestock research helpers during all experiments. The protocol for the specific experiment will take precedence over the SOP when applicable.

I. ANIMAL HUSBANDRY

A. ANIMAL CARE

General husbandry will be in accordance with procedures outlined in FSS-SOP-1. The experimental protocol for each project will assign cows to groups and designate number of pens and their locations. All individual pens will be identified with group and cow numbers. The animals will be placed in the pens 3 days prior to D-day so they become acclimated to the experimental routine. Cows within a group will be placed in sequential order from right to left as you face the feeding boxes.

The udder, hind legs, flanks, and tail switch of each cow should be closely clipped prior to the initiation of the experiment. This will aid in the reduction of fecal and/or urine accumulations which are possible avenues of contamination of milk.

Experimental animals will be closely observed for any departures from the normal in attitude, feed consumption, and milk production, etc. Any indication of ill health or of mastitis will be promptly reported to the FSS Veterinarian so appropriate action may be taken. All pertinent observations and treatments will be recorded on the daily data sheets and in the barn log book.

B. FEEDING PROCEDURES

The type and amount of forage and feeding schedule will be established in the protocol. It is essential that each cow receives the assigned ration and that the consumption of each cow is accurately recorded. All groups should be allowed to eat all available feed whenever possible. Usually, the contaminated hay will be fed twice a day. Only green chop will be fed in the morning. In the evening it will be supplemented with good quality alfalfa hay.

The plastic feeding boxes will be used to transport, weigh, and feed the forage. The boxes will be identified with the group and cow numbers and used only by the assigned cow. Each animal will have a duplicate box so that a clean box can be used at each feeding.

If contaminated hay is to be fed, it will have been preweighed and placed in large plastic bags which contain approximately a ration for one cow. Weight should be verified at the time of feeding. This contaminated hay should be stored well away from the noncontaminated hay and milking and sampling areas. Storage area will be identified as a contaminated area through the use of accepted markers. The forage will be protected from the elements by use of tarps. If green chop is fed, it will usually be harvested prior to each feeding. The ration of green chop for each cow will be weighed in the plastic feeding box, using the 150-kg scale. The area of weighing will be separated from the feeding and milking areas. Plastic sheeting will be placed over the box during transport to the feeding pen.

Unconsumed feed will be weighed at the end of the day and the amount recorded. All contaminated waste and forage will be placed in a large plastic bag and disposed of by burial.

Individually identified rubber tubs will be utilized to feed the dairy concentrate. This ration will be preweighed in the tubs and placed in front of cows at time of milking. Each cow will have two tubs so that one will always be dry and clean. Unconsumed feed should be weighed and recorded on the data sheet. All tubs will be washed following the morning milking.

If a feed problem should arise, such as refusal to eat day-old green chop, wrong ratio of green chop to hay, not enough hay, etc., the LRL should immediately consult with the FSS Veterinarian to determine a solution.

II. MILKING PROCEDURE

While in the main holding pen, prior to milking, each cow will be hosed free of any fecal or urine accumulations. After the cow enters the milking parlor, the udder and teats will be washed with warm water and detergent solution. This solution should be changed for each experimental group. A clean disposable towel will be used for each step of washing and drying.

All milking equipment; i.e., inflations, air tubes, pulsators, portable vacuum pump, etc., will be examined and tested at least 3 days prior to the experiment. All faulty equipment will be repaired and/or replaced by that date.

Every effort will be made to prevent fecal and urine contamination of the milk or milking equipment. Equipment will not be placed on the floor, and milk will not be poured down the floor drains. The actual milking process will follow the techniques listed in FSS-SOP-1.

The milking order will be established so that control cows are milked first, followed by the group with lowest radionuclide burden, and progressing until the final group milked will be carrying the highest burden.

This sequential system of milking will lessen the effect of any inadvertent cross contamination.

Each cow in each experimental group will be milked with a separate milk bucket and claw that is marked with the cow number and group number. The equipment will be used only by that particular cow during the experiment. Common buckets may be used to milk the cows in the control group.

Each cow will be checked for mastitis through use of the strip cup. This foremilk will not be emptied on the floor. A bucket of clean water will be used to rinse the strip cup. If there is evidence of mastitis, the FSS Veterinarian should be notified promptly.

III. SAMPLING TECHNIQUES

Sampling techniques must be standardized so that each sample is collected, handled, and recorded in the same manner. Methods used must avoid cross contamination of either the sample or the sample container. They must be labeled in such a manner as to be readily identifiable and must contain a number of built-in cross-checks so that one error will not make the sample valueless. These cross-checks include the cow number, group number, date, and time information. (Time and date will be written in military style.)

The experimental protocol will establish the number, type, and time of sample collection. The usual samples collected are individual nonformalin and formalin milk, composite milk, hay, green chop, water, and grain samples.

A. SAMPLING IDENTIFICATION

The protocol will assign cows to each group. Within a group the lowest numbered cow will be the first cow sampled, the second lowest numbered cow will be the second cow sampled, etc. This same type of sequential handling will be used for noting the time of sampling.

1. Group I: odd time; i.e., if the first cow in the herd is milked at 0600 (regardless of group), the milk sample for

the first cow within Group I should be recorded at 0615, the third cow at 0625, etc.

2. Time of milking of Group II cows will be recorded as even time; i.e., first cow within the group will be recorded as 0600, the second cow as 0610, the third cow as 0620, etc.
3. Time of milking of Group III cows will be recorded as odd time + 2; i.e., the first cow with the group will be recorded 0607, the second cow as 0617, the third cow as 0627, etc.
4. Time of milking the Group IV cows will be recorded as even time + 2; i.e., the first cow within the group will be recorded 0602, the second cow as 0612, the third cow as 0622, etc.
5. Time of milking of Group V cows will be recorded as odd time + 4; i.e., the first cow within the group will be recorded as 0609, the second cow as 0619, the third cow as 0629, etc.

Hay and green chop samples from each cow should be identified as are the milk samples. The time to use will depend on the time the first animal was fed. For example, if the first cow was fed at 1000 (regardless of group), Group I samples would begin with 1005, Group II with 1000, and Group III with 1007, etc.

The sample identification will be recorded on the data forms and upon "time tape" attached to the proper container.

1. Milk sample tapes will be marked in the following manner.

Project Name
Roman Numeral
Neck Chain No.

Project	RAINOUT		
Group	I	DATE	13 Jun 66
I. D. No.	24	TIME	1205

Military date
24-hour clock

Nonformalin samples will be marked by writing NF on the Cubitainers with a felt marking pen.

2. Tapes for the hay and green chop containers--which are the small plastic bags--are to be marked in the following manner.

Project Name	Project <u>RAINOUT</u>		Military date 24-hour clock
Roman Numeral	Group <u>II</u>	DATE <u>13 June 66</u>	
Neck Chain No.	I. D. No. <u>5</u>	TIME <u>1200</u>	

3. Tapes for the water sample (Cubitainer) and grain samples (plastic containers) are to be marked in the following manner.

Project Name	Project <u>RAINOUT</u>		Military date 24-hour clock
Roman Numeral	Group <u>I</u>	DATE <u>13 Jun 66</u>	
Neck Chain No.	I. D. No. <u>None</u>	TIME <u>0605</u>	

Prelabeling of the sample containers on the "time tapes" with all data except the time will increase the efficiency of sampling and will lessen the possibility of failure to collect a sample. Time will be entered as the sample is collected. The military 24-hour clock will be used.

All milking and sampling equipment will be doubly bagged in heavy plastic when it is transported to or from a field site. This will be done in order to prevent dust contamination and is especially important immediately following an event.

B. MILK SAMPLES

The milk from each cow will be weighed in the milking bucket. Milk will then be carried to the sampling sink, and individual formalin (10 cc. 37% formaldehyde/Cubitainer) and/or nonformalin milk samples will be taken as directed by experimental protocol. Each Cubitainer

should be filled to the level of the break at the shoulder. Spillage will be prevented through the use of a funnel. Each group will have a separate funnel. Following collection of the individual samples, excess milk will be poured into the sink or a group composite container, as established by the protocol. After the bucket is emptied, the complete milking unit will be rinsed with the spray nozzle, placed in the second sink for washing and then in the third sink for disinfection and final rinse. The unit will then be hung on the wall for drying. The sampling sink and funnel will be washed free of any milk prior to sampling the next cow. Wash and rinse solutions will be changed for each group.

If composite samples are required, the excess milk from each cow in the group will be placed in a covered container which is identified with the group number. The required composite samples should be taken only after the milk from all cows in the group has been mixed thoroughly. Following the collection of all composite samples, the milk will be dumped down the drain in the holding pen and the composite container washed thoroughly.

After each Cubitainer is filled, it will be rinsed free of any visible milk residue, placed in a 15" x 24" plastic bag, and the bag closed with a wire tie. During warm weather, crushed ice will be required to prevent spoilage of nonformalin samples during storage and while in transit.

C. FORAGE SAMPLING

Noncontaminated forage will be sampled first. Rubber gloves will be worn to sample the contaminated forage. The radiological safety officer will determine if "anti-C" clothing and/or face masks are required during the feedings and sampling procedures.

Hay and/or green chop samples will be collected according to the protocol. It will designate also whether individual or composite samples are collected. If the individual samples are collected, the total amount of

feed will first be placed in the plastic feed box and weighed, then the forage spread evenly from side to side. One handful of forage from each surface corner and one handful from the bottom center should be taken. The individual handfuls should be ample so as to fill a 9" x 14" 6-mil plastic bag at least two-thirds full and closed with wire ties. All samples from a group will then be placed into a common 15" x 24" bag and secured with wire.

If composite samples are collected, the sample will consist of five handfuls from different areas of the common feed bunk or one handful from the bottom center of each cow's feeding box. It will be identified as a group composite sample.

D. GRAIN AND WATER SAMPLING

Grain will be collected from the bulk supply and placed in the special plastic containers. Normally, only one sample will be collected each morning unless otherwise stated in the protocol. The container will be properly identified with a "time tape" label and according to the protocol.

A Cubitainer of water will be collected from each group's common source of supply or composited from each individual cow's waterer, whichever is applicable, but be consistent. Usually water samples will be collected only in the morning. They will be properly identified as to group and time.

IV. RECORD KEEPING

Too much emphasis cannot be placed upon the importance of clear, complete, and accurate records. An experiment has no value if the results, or factors affecting the results, are not retrievable. All data will be processed as soon as possible either by manual or computer means.

Data for all groups will be recorded in duplicate on the standard computer form. Milk production will also be recorded in the daily record book. See the example computer form as a guide in recording the data in the proper manner. Certain details should be noted: record dates, times, animal numbers, movements, etc., in the dairy barn if not included on the computer form. Attempt to keep running records on this, whenever possible.

If at all possible, one man should attempt to keep the records throughout the day and not depend upon his assistants to add data. It is good practice to limit the number of recorders to two. One man on each team should be designated as the recorder by the LRHL. The LRHL or his deputy should check for errors and discrepancies at the end of each period of recording to prevent errors or deletions.

1. The date will be entered in space provided at upper left-hand corner of form. Use the number style of writing the date; e.g.,

7 Mar 67 should be 03-07-67

12 Aug 67 should be 08-12-67

2. Column 1 is used for the cow number; e.g., if a single-digit number such as 1, fill in the column with 01; if 32, fill in the column as 32.
3. Column 2 should be filled in by use of the 24-hour clock notation; e.g.,

7:30 a.m. should be written 0730

3:30 p.m. should be written 1530

4. Columns 3 and 4 are filled in a similar manner. A single digit is preceded by a zero; e.g.,

5 pounds would be written 05

12 pounds would be written 12

5. Column 4 will be pounds of grain actually eaten.
6. Column 5 is used to show number of samples of milk taken; e.g.,
1 formalin and 1 nonformalin would be 1 1
1 formalin and 0 nonformalin would be 1 0

If composite samples are taken, place a bracket around the samples included in the composite.

7. Remaining columns will be filled out in accordance with the established format. Hay must be weighed in kilograms just before being fed. ASTERISK THE NUMBERS THAT PERTAIN TO CONTAMINATED FEED.
Entries should be made for each feeding regardless of the number of times the group is fed during the day. Uneaten portions should be weighed just after removal from box. Fractional remains should be entered in the third line of columns 6 and 8.

7.5 kg would be written as 075

10.0 kg would be written as 100

0.2 kg would be written as 002

8. Groups are identified on the left margin of the form. When a composite sample is taken, brackets should so indicate. The time the sample was taken is written in column 2.
9. Page number should be placed in the upper right-hand corner; e.g., page 12 would appear as:

1	2
44	45

10. A zero should be entered in all columns that do not apply to a particular cow.
11. The bottom part of sheet and the "other" column can be utilized for written comments on the health of animals, weather conditions, and other factors that might affect the experiment.
12. The original goes to the Sample Control Officer; the duplicate is kept in the dairy barn records in a folder labeled with the project name.

V. EQUIPMENT DECONTAMINATION

If cross contamination is to be avoided, equipment must be adequately "deconned" before it is used again. This is especially true of equipment that is utilized for more than one animal. Personnel will rigidly adhere to all clothing requirements established by the BEP Rad-Safe Officer. Contaminated waste will be sealed in large plastic bags. These will be buried daily. If the forage wagon and the green chopper are used to harvest both the contaminated and noncontaminated feed, the noncontaminated alfalfa will be harvested first. After the contaminated green chop is harvested, the equipment should be pressure washed free of all visible residue by using the "Kleen-King" or REECO-Rad-Safe equipment. Decontamination procedures will be conducted well away from the barn where there will be no possibility of run-off into the lot area. Personnel will wear "D-CON" clothing and boots during the procedures and WILL REMOVE THEM BEFORE ENTERING THE AREA 15 FACILITY.

Washing of the milking equipment, as described in Section II, should be adequate to prevent cross contamination. However, the wash and rinse solutions should be changed frequently. Personnel who milk should not enter the sampler room without changing into clean clothes and footwear.

NO VISITORS!

Each morning the feed boxes and grain tubs should be pressure cleaned with the "Kleen-King" within the holding-pen area so that the wash water

does not splash about the milking area. Great care must be exercised so that the feed boxes and tubs are used for the assigned cow.

Blankets will be used to protect cows from the elements when on field experiments. The blankets will be removed from the cows after they leave the field site. REECo-Rad-Safe personnel will vacuum and/or pressure wash the cows at the muster station. If it is deemed necessary, they will be washed again after their return to Area 15. Equipment used for "deconning" the harvesting implements will be utilized.

APPENDIX IX

MASTITIS INCIDENCE IN INDIVIDUAL COWS

COW NO.	MAY-JUN 1964	JUL-SEP 1964	OCT-DEC 1964	JAN-MAR 1965	APR-JUN 1965	JUL-SEP 1965	OCT-DEC 1965	JAN-MAR 1966	APR-JUN 1966
1		23 Jul 4 Aug 9 Sep		10 Jan 21 Jan	17- 20 Apr 13- 16 May			23- 24 Mar	
2	17- 27 Jun	7-8 Jul			17- 20 Apr 20- 21 Jun				
5	18- 20 Jun	7-8 Jul 17- 20 Jul		4-5 Mar	17- 20 Apr				periodical- ly all thru Apr and May, 9-10 Jun
11		5-7 Jul			17- 20 Apr				
12	25- 28 Jun						10- 22 Dec		
13		22- 30 Aug		28- 31 Mar	19- 21 Jun		9- 16 Dec	5-6 Jan 22- 23 Jan	
15	18- 20 Jun 27- 29 Jun	12- 16 Jul		19- 22 Feb 9- 10 Mar	6- 15 Apr 23- 26 May				10-20 Jun
17		19 Sep							
18		26- 30 Aug			15- 30 Apr				8 Apr

APPENDIX IX (Continued)

COM NO.	MAY-JUN 1964	JUL-SEP 1964	OCT-DEC 1964	JAN-MAR 1965	APR-JUN 1965	JUL-SEP 1965	OCT-DEC 1965	JAN-MAR 1966	APR-JUN 1966
19		2-3 Sep							
22					5-6 Apr				
23				8-12 Feb 4-6 Mar 20-24 Mar	5-6 Apr				
24								24-26 Mar	
25						11-13 Aug			
26								3-6 Mar 23-31 Mar*	
27									
28			29 Dec- 3 Jan*					26 Mar- 3 Apr	22-23 May 27-28 Jun
29									
43							10-27 Oct*		
44							6-11 Nov		
45									1-4 Apr
46									
47									
48							8-9 Dec		

*Acute Mastitis

APPENDIX X

PRODUCTION DATA FOR USPHS DAIRY HERD

COW NO.	LACTA- TION NO.	PERIOD AND LENGTH OF LACTATION	DAYS DRY	DAYS OPEN	NO. OF BREEDINGS	DAYS CAR- RIED CALF	ACTUAL MILK PROD.	DHIA ADJUSTED PROD.	AVG. BUTTER FAT %	RELATIVE VALUE DHIA
							POUNDS (LITERS)	POUNDS (LITERS)		
1	4*	7/20/64- 5/26/65 320 days	90	123	2X--Nat.	187	9,491 (4,314)	9,298 (4,226)	3.6	N.V.
	5*	8/24/65- 6/1/66 280 days	**	**	3X--2AI 1 Nat.	**	11,463 (5,210)	11,921 (5,419)	N.V.	N.V.
2	4*	11/23/64- 9/3/65 285 days	84	85	1X--AI	199	9,851 (4,478)	10,254 (4,667)	3.0	N.V.
5	4*	1/4/65- 11/9/65 309 days	83	115	1X--Nat.	194	11,221 (5,100)	11,333 (5,151)	3.6	103
11	3*	10/9/64- 10/27/65 383 days	①	①	5X--3AI 2 Nat.	①	10,082 (4,583)	8,826 (4,011)	3.6	N.V.
12	3*	2/19/65- 12/22/65 306 days	64	88	3X--Nat.	218	11,932 (5,423)	12,167 (5,530)	3.7	106
13	2*	7/26/64- 5/26/65 304 days	19	43	1X--Nat.	261	8,738 (3,972)	9,612 (4,369)	3.7	N.V.

*Estimated--as no records prior to purchase.

**Cow No. 1, sick during May--died 11 June 1966--some factors not known.

① Unknown--as not freshened by 1 July 1966.

N.V. = No value.

APPENDIX X (Continued)

COW NO.	LACTATION NO.	PERIOD AND LENGTH OF LACTATION	DAYS DRY	DAYS OPEN	NO. OF BREEDINGS	DAYS CAR-RIED CALF	ACTUAL MILK PROD. POUNDS (LITERS)	DHIA ADJUSTED PROD. POUNDS (LITERS)	AVG BUTTER FAT %	RELATIVE VALUE DHIA
13	3*	6/13/65-2/17/66 249 days	103	80	1X--Nat.	169	11,516 (5,235)	11,760 (5,345)	3.4	83
15	6*	1/8/65-12/11/65 337 days	119	173	4X--1 AI 3 Nat.	164	14,807 (6,731)	14,066 (6,394)	3.3	114
16	4*	5/23/64-8/5/65 439 days	190	352	3X--1 AI 2 Nat.	87	17,064 (7,756)	13,787 (6,267)	3.3	N.V.
17	2*	7/14/64-11/28/64 137 days	347***	137	3X--1 AI 2 Nat.	0	3,269 (1,486)	6,028 (2,740)	N.V.	N.V.
18	4*	2/15/65-12/1/65 289 days	57	67	1X--Nat.	222	11,671 (5,305)	11,787 (5,358)	3.3	93
19	7	1/10/65-12/8/65 332 days	267	232	3X--Nat.	100	13,836 (6,289)	13,548 (6,158)	3.6	121
21	2	5/29/65-3/30/66 305 days	75	100	1X--Nat.	205	12,200 (5,545)	14,154 (6,434)	3.7	103

*Estimated--as no records prior to purchase.

***Short lactation--because of illness.

N.V. = No value.

APPENDIX X (Continued)

CON/ NO.	LACTA- TION NO.	PERIOD AND LENGTH OF LACTATION	DAYS DRY	DAYS OPEN	NO. OF BREEDINGS	DAYS CAR-RIED CALF	ACTUAL MILK PROD. POUNDS (LITERS)	DHIA ADJUSTED PROD. POUNDS (LITERS)	AVG. BUTTER FAT %	RELATIVE VALUE DHIA
24	4	8/9/64-6/22/65 317 days (2)	71	106	1X--Nat.	211	12,552 (5,705)	12,540 (5,700)	2.9	N.V.
	5	9/1/65-6/30/66 303 days	(1)	96	1X--Nat.	207	12,884 (5,856)	13,012 (5,915)	N.V.	N.V.
25	5	7/18/65-6/16/66 335 days	(1)	270	1X--AI	65	16,924 (7,692)	16,247 (7,385)	3.0	103
26	3	10/29/64-7/14/65 262 days (2)	220	191	1X--Nat.	72	11,729 (5,331)	13,168 (5,985)	3.0	N.V.
27	1	7/3/64-6/15/65 347 days (2)	50	117	1X--AI	230	13,999 (6,359)	16,185 (7,357)	3.4	N.V.
	2	8/4/65-6/16/66 316 days	(1)	98	2X--1 AI 1 Nat.	218	15,678 (7,126)	17,515 (7,961)	N.V.	N.V.
28	5	4/13/65-12/30/65 261 days	68	51	1X--Nat.	210	13,675 (6,212)	14,905 (6,775)	3.6	119
29	3	7/30/64-6/10/65 314 days (2)	81	112	1X--Nat.	203	13,331 (6,060)	13,455 (6,116)	3.5	N.V.

(1) Unknown--as not freshened by 1 July 1966.

(2) Not in herd during complete period.

N.V. = No value.

APPENDIX X (Continued)

COW NO.	LACTATION NO.	PERIOD AND LENGTH OF LACTATION	DAYS DRY	DAYS OPEN	NO. OF BREEDINGS	DAYS CAR-RIED CALF	ACTUAL MILK PROD. POUNDS (LITERS)	DHIA ADJUSTED PROD. POUNDS (LITERS)	AVG. BUTTER FAT %	RELATIVE VALUE DHIA
43	1	2/12/65-12/17/65 306 days ②	61	90	1X--AI	216	12,631 (5,750)	15,940 (7,245)	4.1	N.V.
44	4	2/2/65-11/20/65 291 days ②	135	149	1X--AI	142	12,340 (5,609)	12,838 (5,835)	2.9	N.V.
45	3	2/4/65-11/4/65 273 days	101	93	1X--AI	180	14,655 (6,661)	16,000 (7,273)	3.2	114
46	3	4/5/65-2/17/66 318 days ②	128	156	2X--1 AI 1 Nat.	162	13,743 (6,247)	14,180 (6,445)	3.3	94
47	5	3/20/65-1/7/66 293 days ②	86	100	1X--1 AI	193	14,979 (6,089)	15,129 (6,877)	3.3	106
48	2	9/8/65-6/1/66 265 days	①	123	1X--Nat.	142	10,531 (4,786)	11,719 (5,327)	5.5	N.V.
Avg.	3.5 ±1.4	303 days ±50	102 ±5.8	128 ±67	1.7	171 ±60	12,385 ±2,703 (5,604 ±1,211)	12,906 (5,866)	3.4	105

① Unknown--as not freshened by 1 July 1966.

② Not in herd during complete period.

N.V. = No value.

APPENDIX XI

LIST OF COWS ARRANGED ACCORDING TO FIELD EVENTS AND TYPE OF EXPOSURE

EXPERIMENT	COW NUMBERS			REMARKS
	CONTAMINATED HAY	INGESTION CONTAMINATED GREEN CHOP	INHALATION CONTROL	
TORY IIC 20 May 64		2, 5, 6, 7.	1, 9, 10, 11, 12, 13, 15, 17.	
RB-1 14 Aug 64				13, 15. (I.V. In- jection)
KIWI--B4E 28 Aug 64 10 Sep 64		4, 7, 9, 17. 1, 4, 7, 8, 13, 16, 17, 18, 20, 21.	7, 9. 1, 8, 19, 21.	
SULKY 18 Dec 64	(11, 21, 23, 24, 25, 26, 28, 29.*)		1, 8, 13, 27.	(2, 16, 22.**)
TNT 12 Jan 65	1, 8, 11, 13, 21, 23, 24, 25, 26, 27, 28, 29.			2, 16, 22.
PALANQUIN 14 Apr 65	12, 13, 16, 19, 21, 22, 24, 25, 28.	15, 18, 23, 26, 27, 29.	1, 2, 5, 11. (4, 7, 9.***)	Each cow served as own control.
MILKRUN 11 Aug 65				Remainder of lactat- ing herd.
				12, 15, 18, 19, 21, 25, 27, 28. (Oral Dose)

*Ingestion + inhalation

**Ingestion, control

***Inhalation, sacrifice

APPENDIX XI (Continued)

EXPERIMENT	COW NUMBERS			REMARKS
	CONTAMINATED HAY	INGESTION CONTAMINATED GREEN CHOP	INHALATION CONTROL	
HAYSEED 4 Oct 65	12, 19, 21, 25.	15, 18, 27, 29, 43, 44, 45, 48.	1, 5, 46, 47.	13, 24, 28.
ALFALFA 21 Jun 66	5, 26, 29, 47.	2, 12, 13, 15, 16, 17, 18, 44.	21, 28, 43, 45.	19, 24.

APPENDIX XII

LIST OF COWS ARRANGED BY COW NUMBER SHOWING PARTICIPATION IN EXPERIMENTS

COW NUMBER	TORY IIC 20 May 64	RB-1 14 Aug 64	KIWI--B4E 28 Aug 64	KIWI--B4E 10 Sep 64	SULKY 18 Dec 64
1	Inhalation		Control	Ingestion	Inhalation
2	Ingestion G. C.				Control
4			Ingestion	Ingestion	
5	Ingestion G. C.				
6	Ingestion G. C.				
7	Ingestion G. C.	Control	Ingestion	Ingestion	
8			Control	Ingestion	Inhalation
9	Inhalation	Control	Ingestion	Ingestion	
10	Inhalation				
11	Inhalation				Ingestion + Inhalation
12	Inhalation				
13	Inhalation	Injection I.V.		Ingestion	Inhalation
15	Inhalation	Injection I.V.			
16				Ingestion	Control
17	Inhalation		Ingestion	Ingestion	
18				Ingestion	
19			Control		
20				Ingestion	
21			Control	Ingestion	Ingestion + Inhalation
22					Control
23					Ingestion + Inhalation
24					Ingestion + Inhalation

APPENDIX XII (Continued)

COW NUMBER	TORY IIC 20 May 64	RB-1 14 Aug 64	KIWI--B4E 28 Aug 64	KIWI-B4E 10 Sep 64	SULKY 18 Dec 64
25					Ingestion + Inhalation
26					Ingestion + Inhalation
27					Inhalation
28					Ingestion + Inhalation
29					Ingestion + Inhalation

COW NUMBER	TNT 12 Jan 65	PALANQUIN 14 Apr 65	MILKRUN 11 Aug 65	HAYSEED 4 Oct 65	ALFALFA 21 Jun 66
1	Ingestion Hay	Inhalation		Inhalation	
2	Control	Inhalation			Ingestion G. C.
4		Inhalation Sacrifice			
5		Inhalation		Inhalation	Ingestion Hay
7		Inhalation Sacrifice			
8	Ingestion Hay				
9		Inhalation Sacrifice			
11	Ingestion Hay	Inhalation			
12		Ingestion Hay	Oral Dose	Ingestion Hay	Ingestion G. C.
13	Ingestion Hay	Ingestion Hay		Control	Ingestion G. C.
15		Ingestion G. C.	Oral Dose	Ingestion G. C.	Ingestion G. C.

APPENDIX XII (Continued)

COW NUMBER	TNT 12 Jan 65	PALANQUIN 14 Apr 65	MILKRUN 11 Aug 65	HAYSEED 4 Oct 65	ALFALFA 21 Jun 66
16	Control	Ingestion Hay			Ingestion G. C.
17					Ingestion G. C.
18		Ingestion G. C.	Oral Dose	Ingestion G. C.	Ingestion G. C.
19		Ingestion Hay	Oral Dose	Ingestion Hay	Control
21	Ingestion Hay	Ingestion Hay	Oral Dose	Ingestion Hay	Inhalation
22	Control	Ingestion Hay			
23	Ingestion Hay	Ingestion G. C.			
24	Ingestion Hay	Ingestion Hay		Control	Control
25	Ingestion Hay	Ingestion Hay	Oral Dose	Ingestion Hay	
26	Ingestion Hay	Ingestion G. C.			Ingestion Hay
27	Ingestion Hay	Ingestion G. C.	Oral Dose	Ingestion G. C.	
28	Ingestion Hay	Ingestion Hay	Oral Dose	Control	Inhalation
29	Ingestion Hay	Ingestion G. C.		Ingestion G. C.	Ingestion Hay
43				Ingestion G. C.	Inhalation
44				Ingestion G. C.	Ingestion G. C.
45				Ingestion G. C.	Inhalation
46				Inhalation	
47				Inhalation	Ingestion Hay
48				Ingestion G. C.	